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Lowenberg, Mrs. B. F.
Usiskin, L. A.
*London, N.*5
Orton, H. S.
*London, N.*6
Vig, P.
Wraith, Mrs. K. W. L.
*London, N.*13
Finkel, W.
Fisher, A. E.
*London, N.*14
Butters, Miss A. P.
*London, N.*20
Cryer, B. S.
*London, N.*21
Oliver, D. H.
Trend, J. P.
*London, N.W.*1
Smith, B. D.
Smith, D. I.
*London, N.W.*2
Levason, J. A.
*London, N.W.*3
Malik, Miss R.
Russell, L. H.
*London, N.W.*4
Cohen, H. I.
Doran, S. K.
Warner, Miss D. E. M.
*London, N.W.*5
Emery, B. J.
Panter, Miss A.
London, N.W.8
Carvalho, Mrs. E. M.
Miller, B. H.
*London, N.W.*9
Moss, J. P.
*London, N.W.*10
Sider, Mrs. V.
*London, N.W.*11
Bergman, R.
Golden, A.
*London, S.E.*1
Rushton, M. A.
Tulley, W. J.
*London, S.E.*3
Ward, Mrs. A. D.
*London, S.E.*4
Davies, J. H.
*London, S.E.*5
Leighton, B. C.
*London, S.E.*10
Bass, T. P.
*London, S.E.*15
Lewis, P. E.
*London, S.E.*18
Pringle, K. E.
*London, S.E.*25
Nichols, J.
*London, S.W.*1
Campbell, R. A.
Niven, W. N. McL.
Steadman, B. St. J.
*London, S.W.*2
Barnett, J. D. W.
*London, S.W.*3
Hutchinson, G. T.
Morris, V. B.
*London, S.W.*4
Breach, Mrs. J. J.
*London, S.W.*6
Bane, B.
*London, S.W.*7
Levy, Mrs. H.
*London, S.W.*12
Brien, A. B.
*London, S.W.*15
Parr, P. T.
Schrotter, Miss E. C.
*London, S.W.*16
Nesbitt, A.
*London, S.W.*19
Kettle, R. G.
Oliver, Mrs. Una
Scott, Miss M. K.
*London, S.W.*20
Johnson, Mrs. E. M.
*London, W.*1
Adams, Miss S.
Allan, F.
Beresford, J. S.
Berman, M.
Bird, E. J. R.
Campbell, A. C.
Clarke, N. F.
Endicott, C. L.
Foster, E. S.
Freeman, H. D.
Fry, J. C.
Greenish, V. A. F.
Greig, W. B. W.
Grossmann, W.
Halden, J. R.
Hardy, E. A.
Henry, C. Bowdler
Henry, T. Cradock
Hovell, J. H.
Kettle, M. A.
Leatherman, G. H.
McCallin, S. Granger
Patwardham, Miss S. V.
Pook, R. S.
Richards, H.
Ritchie, Miss J.
Rix, R. E.
Rose, J. S.
Rydemark, J. E.
Schachter, H.
Schofield, J. W.
Schuler, L. H.
Sharland, R. J.
Stephens, P. Maxwell
Taralrud, M.
Tupling, L. P.
Walker, F. A.
Westbrook, E. A.
Willcocks, R. W.
Wilson, H. E.
Wongtschowski, K. G.

London, W.3
Evans, Miss L. G.
Newton, S. B.
London, W.5
Chmielewski, J. K.
Shotts, Miss N.
London, W.6
MacInerney, Miss J.
London, W.11
Lynch, Miss E.
London, W.13
Shotts, A.
London, W.14
Taylor, A. G.
London, W.C.1
Ballard, C. F.
Fletcher, G. G. T.
Heffer, P. T.
Jefferson, Miss C.
Mills, J. R. E.
Winter, G. B.
London, W.C.2
McCall, Miss M. C.
McDonald, J. D. H.
Walther, D. P.

II. England

Bedfordshire
Biggleswade
Bunker, D. G.
Dunstable
Welton, Mrs. A. M.

Berkshire
Faringdon
Rayne, J.
Maidenhead
Bailey, J. C.
Still, Miss E. M.
Walker, D. Greer
Newbury
Hope, H. D. A.
Pangbourne
Caseley, Miss R.
Softley, J. W.
Wallingford
Bell, J. A.
Wantage
England, Mrs. M.

Buckinghamshire
Amersham
Butler, F. H.
Aylesbury
Beaton, A. G.
Isaacson, K. G.
Johnson, J. S.
Beaconsfield
Chapman, H.
James, P. M. C.
Gerrards Cross
Stobie, C. W.

Cambridgeshire
Cambridge
Banke, P. H.
Pickles, R. B.

Cheshire
Appleton
Knowles, C. C.
Birkenhead
Burston, W. R.
Bramhall
Andrew, Miss E. M.
Holloway, P. J.
Cheadle
Miller, Mrs. P. S.
Chester
Johnson, F. K.
Hyde
Hughes, J. P.
Wilmslow
Turner, Mrs. B. M. A.
Wirral
Bush, P. G.
Hopper, J.
McCracken, J. G.
Widdowson, A. R.

Cornwall
Bude
Trays, W. N.
St. Austell
Perks, E. J.
Saltash
Bernard, W. E.
Truro
Thomas, R. J.

Cumberland
Carlisle
Roberts, G. H.

Derbyshire
Belper
Foster, B. A.
Foster, P. L.
Derby
McKane, N. B.

Devon
Dartmouth
Hobdell, H. G.
Exeter
Shapland, A. F. D.
Newton Abbot
Coyle, P. R. W.
Paignton
Whitfield, P. F. G.
Plymouth
Burley, M. A.
Endacott, D. J.

Durham
Darlington
Jameson, G. D.
South Shields
Steel, G. H.
Sunderland
Dixon, D. A.
Pettman, J. R.

Essex
Basildon
Coker, F. L.
Billericay
Hathaway, R. F.
Colchester
Seymore, A. J. H.
Epping
Brearley, Mrs. H. E.
Goodmayes
Sherwood, H.
Hornchurch
Luffingham, J. K.
Ilford
Clark, A. G.
Leigh-on-Sea
Clough, E. O.
Westcliff-on-Sea
Salter, R. C. P.
Woodford Green
Martin, H. C.
Ta'Bois, N. C.

Gloucestershire
Bristol
Blyth, P. J.
Nicol, W. A.
Seel, D.
Stephenson, J. C.
Wilkie, J. K.
Cheltenham
Dagger, T.
Valentine, L. H.
Cirencester
Hardingham, A. J.
Frampton-on-Severn
Everard, G. D.
Gloucester
Cookson, A. M.

Hampshire
Bournemouth
Connors, Miss M.
Holmes, B.
Hooper, J. D.
Wood, N. J.
Havant
Woodward, H. A.
Portsmouth
Dickson, G. C.
French, J. H.
Tipnis, A. K.
Townend, B. R.
Ringwood
Webb, Miss J. M.
Williams, E. B.
Romsey
Fanner, M. H.
Ryde (Isle of Wight)
Audsley, C. W.
Southampton
Davidson, I. F.
Winchester
Broadway, R. T.

Herefordshire
Hereford
Vaus, K.

Hertfordshire
Bishop's Stortford
Dodd, Miss J. M.
Cheshunt
Munday, M. J.
Hatfield
Kerr, G. A.
Kings Langley
Boyd-Cooper, B.
Rickmansworth
Morse, P. H.
Tait, R. V.
St. Albans
Clifton, D. R.
Crawford, J. F.
Watford
Leech, H. L.
Marx, R.
Welwyn
Dickson, W. L.

Kent
Ashford
Glass, D. F.
Beckenham
Sandiford, H. E.
Bexley Heath,
Brenchley, M. L.
Bromley
MacGregor, Miss F. A.
West, V. C.
Canterbury
Bradley, P. E.
Chislehurst
Tata, F. R.
Dover
Rumble, J. D.
Gillingham
Ellis, D. S.
Sandwich
Irwin, L. M.
Sevenoaks
Christian G. C.
Di Biase, D. D.
Rubie, G. J.
Rumble, J. F. S.
Sidcup
Wreakes, G.
Sittingbourne
Thorn, N. K.
Tenterden
Crease, J. A.
Tunbridge Wells
Cross, Miss M.
McAlpine, A. M.
Page, G. Scott
Pilbeam, J. F.
Scoones, J. M.
Spencer, J. S.
Taylor, B. P.
White, Miss B. E. E.

Lancashire
Barroldswich
Chapman, Mrs. P. A.
Bolton
Powell, J. E.
Formby
Wilson, A. J.
Liverpool
Atherton, J. D.
Clifford, E. J. S.
Huggins, D. G.
Lovius, B. B. J.
Murray, Miss J. P.
Wynne, T. H. M.
Manchester
Aron, B. D.
Batten, A. G.
Cruikshank, A. J.
Eirew, H. L.
Hartley, D. T.
Iyer, V. S.
Jackson, Mrs. S. R.
Kürer, J.
Noar, G. A.
Roberston, N. R. E.
Senior, W. B.
Wood, Miss J. H.
Oldham
Hilton, R.
Ormskirk
Pogrel, H.
Preston
Timms, D. G.
Salford
Miller, E.
Sarll, D. W.

Southport
Campbell-Wilson, Miss M.
Robb, G. C.
Wigan
Langford, L. F.

Leicestershire

Leicester
Chamberlain, G. H.
Downing, F. J.
O'Brien, J. D.
Parker, C. D.
Reynolds, B. F.
Smith, K. A.
Smith, T.

Lincolnshire

Grimsby
Bull, C. C.
Lincoln
Greenwood, A. W.
Scunthorpe
Benzies, P. M.

Middlesex

Edgware
Strauss, K.
Enfield
Dimock, J. R.
Gould, M. S. E.
Hayes
Swift, P. A.
Heston
Valentine, H. B.
Hounslow
Mandiwall, H.
Isleworth
Hardy, D. K.
Kenton
Baker, C. D.
Northwood
Hudson, J. A.
Pinner
Eady, B.
Fulstow, E. D.
Ruislip
Rogers, D. A.
St. Margaret's-on-Thames
Lindon, Mrs. E. G.
Staines
Carr, A. S.
Twickenham
Peace, Mrs. H. C.

Norfolk

Norwich
Bird, R. G.
Sheringham
Dumbrell, Miss J. M.

Northamptonshire

Northampton
Hughes, H. D. P.
Phillips, J. E.
Wilson, C. P.

Northumberland

Newcastle upon Tyne
Hallett, Prof. G. E. M.
Littlefield, W. H.
Stubley, R.
Weyman, Miss J.
Stockfield upon Tyne
Bennett, D. T.
Wylam
Johnson, D. B.

Nottinghamshire

East Bridgeford
Gould, D. G.
Nottingham
Attenborough, J. L.
Frankland, W.
Tredgold, H. V. G.

Oxfordshire

Banbury
Fraser, A.
Oxford
Harvey, P. D.
Hayton-Williams, D. S.
Savage, M.

Shropshire

Church Stretton
Knight, J.
Oswestry
Broadbent, B. T.
Shrewsbury
Scott, M. F.

Somerset

Bath
Catchside, J.
Franks, Miss F. L.
Langport
Alexander, J. M.
Taunton
Poulter, N. M.

Staffordshire

Allbrighton (near Wolverhampton)
Williams, T. G. N.
Codsall
Huddart, A. G.
Lichfield
Standing, R. A.
Stafford
Levison, H.
Stoke-on-Trent
Campbell, A. Courtney
Stone
Friend, Mrs. D. J.

Suffolk

Beccles
Strange, Mrs. M. C.
Ipswich
Broadway, E. S.
Churchyard, R. C.
Lowestoft
Clarkson, J. N. K.
Jones, F.

Surrey

Ashtead
Houston, W. J. B.
Camberley
Friend, G. C.
Jadwat, I. A.
Rice, V. G.
Cheam
Boa, J. T.
Chipstead
Burnapp, D. R.
Claygate
Metcalf, J.
Croydon
Hill, N. L.
Dorking
Shepperd, R. V.
Epsom
McDonald, Mrs. S.
Esher
Franklin, Mrs. J. A.
Manning, Mrs. J. D.
Guildford
Coyle, Miss M. N.
Glover, E. A.
Nelson, J.
Roberts, Mrs. S.
Hindhead
Ogston, R. D.
Leatherhead
Bigg, Miss F. J.
Limpsfield
Titford, K. R.
Redhill
Tittle, J. J.
Reigate
Belcher, R. J.
Richmond
Bell, R. S.
Howard, R. D.
Surbiton
Frischmann, L.
Mayer, J. W.
Upson, N.
Sutton
Baldwin, Miss B. J.
Bransby-Zachary, G. M.
Bulow, C. F. H.
Wood, Mrs. R. M.
Wallington
Furness, M. J.
Weybridge
Christy, D. F.
Woking
Halliday, R. W.
Readings, P.
Reid, D.
Sperryn-Jones, G.
Worcester Park
Bradley, Miss J. A.

Sussex

Battle
Black, A.
Edworthy, S. W.
Bognor Regis
Adam, K. W.
Brighton
Greenwood, A. B.
Chichester
Robertson-Ritchie, D.
Robertson-Ritchie, Mrs. E. L.
Crawley
Dakers, G. H.
Crowborough
Bligh, J. A.
Eastbourne
Abbey, R. A.
Allcorn, A. G. T.
Angelman, J.
Collins, R. G.
Crowther-Kemp, Mrs. J. M.
Cullingford, J. T. P.
Down, G. R.
Gray, N.
Griffith, H. G.
Horton, J. J.
Martin, D. W.
Whittaker, L. B.
Wilson, R. A.
East Grinstead
Whitelegg, J. G.
East Hoathly
Lester, H.
Etchingham
Ardouin, D. G. F.
Fittleworth
Wylde, Mrs. A. S.
Hankham (nr. Pevensey)
Whitling, I. E.
Hastings
Plint, D. A.
Haywards Heath
Crossman, I. G.
Grice, A. R.
Horsham
Pearsall, M. L. H.
Hove
Harwood, W. U.
Shenton, F. C.
Taylor, S. B.
Littlehampton
Brown, K. H.
St. Leonards-on-Sea
Young, Miss E. M.

Warwickshire

Birmingham
Davis, Mrs. M. E. H.
Day, A. J. W.
Foster, T. D.
Holick, R. L. B.
Hutton, J. L.
Keniry, A. J.
Menezes, D. M.
Norris, N.
Stanley, Mrs, V. K.
Tibbatts, Mrs. M. A.
Coventry
Breakspear, E. K.
Briggs, C. P.
Kenilworth
Whitworth, J. H.
Solihull
Cutler, M.
Kerr, Miss M. R.
Sutton Coldfield
Townend, P. I.

Wiltshire

Amesbury
Horswill, P. N.
Chippenham
Swann, A. J.
Devizes
Campbell, Miss D. M. Y.
Fawcett, Mrs. A.
Salisbury
Godfrey, O. Harcourt
Hall, J. J.

Worcestershire

Bromsgrove
Munns, D.
Great Malvern
Edmonds, W. H.
Godfrey, W. G.
Malvern
Wallis, R.
Stourbridge
Watkins, B. N.

Yorkshire

Batley
Heylings, R. T.
Bradford
Frazer, Mrs. J.
Wood, T. Jason
Doncaster
Booth, M. H.
Hull
Webb, G. H.
Leeds
Gravely, J. F.
Jackson, D.
Marsh, W.
Miller, J.

Newell, M. J.
Sclare, Miss R.
Middlesbrough
Cook, J. T.
Potts, Miss A.
Scarborough
Priestley, P. J. M.
Sheffield
Alexander, Mrs. M.
Alexander, S. H.
Gardiner, J. H.
Price, A. H. K.
Strensall
Bowen, E. J.

III. Wales

Aberystwyth
Evans, W. D. P.
Barry
Hellier, R. O.
Cardiff
Brown, W. A. B.
Cousins, A. J. P.
Lewis, A. S.
Colwyn Bay
Duchesne, H. W.
Llandrindod Wells
Capleton, Mrs. L. M.
Llandudno
Jones, J. E.
Swansea
Parry, H. L.

IV. Scotland

Aberdeen
Logie, D.
McDonald, A. A. M.
Bucklyvie
White, Prof. T. C.
Dunblane
Hood, M. R.
Dumfries
Baker, A.
Dundee
Archibald, W. C.
Martin, J. H.
McCartney, T. P. G.
McEwen, J. D.
Munro, D.
Edinburgh
Buchan, A.
Hargreaves, J. A.
Haynes, S.
Hopkin, G. B.
Logan, W. Russell
Miller, Miss M. N.
Forfar
Barrie, W. J. M.
Glasgow
Anderson, H. A.
Campbell, J.
Clark, W. J.
Cockburn, A.
Delaney, C. J.
Gibson, A. C. L.
Houston, J. G.
James, G. A.
Thomson, Mrs. C. M.
Webster, Miss E. M.
Grangemouth
Stevenson, Wm.
Hawick
Govan, I. G.
Inverness
Ridley, Miss D. R.
Kirkcaldy
Mears, Miss R.
Woods, A. R. H.
Paisley
McKechnie, R.
Portree
MacLeod, D. N.
Prestwick
MacAlpine, Miss M. T. N.
Stirling
McGonigal, F.

V. Ireland

Bangor
Dallas, H. A.
Belfast
Adams, C. P.
Bonnar, Miss E. M.
Bonnar, E. T.
Hobson, G. S.
Richardson, A.
Richardson, Mrs. M. E.
Taylor, Miss B.
Cork
O'Connor, P. J.
Dublin
Clinch, L. M.
Dockrell, R. B.
Finn, S. D.
Fitzgerald, G. M.
Friel, S.
Keith, J. E.
Kennedy, G. F.
MacCauley, F. J. L.
Thurles
Connolly-Meagher, T. A.

VI. Overseas Members

Australia
Adamson, K. T.
Bowden, B. D.
Cox, N. J.
Crisp, B. C.
Gerraty, B. J.
Heath, J. R.
Norton, R. Y.
Spring, D. F.
Taylor, A. Thornton
Watson, D. C.
Wenck, R. D.

Canada
Copeland, G. P.
Eastwood, A. W.
Franklin, G.
Fransblow, P.
Hackie, T. J.
Hargadon, K. L.
Mulligan, W. O.
Oliver, H. T.
Yip, A. S. G.

Canary Islands
Gonzalez, R.

Egypt
Chohayeb, Mrs. Aida

France
Démogé, P. H.
Gugny, G.
O'Meyer, R. X.
Schouker-Jolly, M.

Germany
Lervy, W. K.

Greece
Tsaltas, G. K.

Hong Kong
Mak, K. L.

India
Ghosh, A. S.
Patel, V. B.

Italy
Magni, F.

Jamaica
Lyn, M. R.

Malaysia
Chan, B. K.
Cheah, C. K.
Choo, T. C.
Lee Chee Onn, J.
Lee Chin Kung
Leong, C. T.
Porterfield, M. F.

Malta
Demajo, A.
Manara, G.

New Zealand
Ashby, J. W.
Cook, C. C.
Gilbert, G. H.
Lang, E. T.
Suckling, J. G.
Willis, L. E.

Norway
Aamodt, A. C.
Engh, Olav, Jun.
Krogstad, Olav
Selmer-Olsen, R.

Rhodesia
Robson, F. F.

S. Africa
De Villiers, J. F.
Faisinger, B. E.
MacLeod, D. N.
Oosthuizen, L.

S. America
Abensur, J. (Peru)
Brears, O. B. (Ecuador)

Sweden
Ahlgren, J.
Billberg, B.
Granerus, R.
Granse, K. A.
Ljungdahl, L.
Lundström, A.
Mortenson, S. Å.
Pihl, Miss E. M. K.
Tegner, G.
Volmer Lind, H. C.
Werner, S. H.

Switzerland
Hotz, R.

U.S.A.
Bell, L. A.
Blausten, S.
Coval, N. M.
Croll, R. O.
Goldstein, M. C.
Gosman, S. D.
Gottlieb, A. W.
Grossman, R. C.
Jann, H. W.
Kelsten, L. B.
Moss, G. W.
Sachs, N. J.
Sillman, J. H.

Zambia
Ovington, H. M. J. Y.

'THERE'S A DIVINITY THAT SHAPES OUR ENDS, ...'

A. J. WALPOLE-DAY, F.D.S., B.D.S., D.Orth. R.C.S.

Consultant Orthodontist, Birmingham Dental Hospital

Members of the British Society for the Study of Orthodontics, I am very conscious of the great honour you have accorded me in electing me your president for 1965. Apart from your wish to honour me, I am sure that it is intended also as a tribute to The Birmingham Dental School and all my colleagues who live and work in the Midlands. So on behalf of all, I thank you.

It is the custom for the president of a learned Society to deliver an inaugural address to show that the new session has commenced, but in this Society there is no tradition or custom which determines the form that it should take.

In the early days of our Society it was usual for the address to be quite short and to be followed by one or more short communications.

The idea of giving the address did not occur to anyone until 1916 when Mr. J. E. Spiller gave an address entitled ' Orthodontics, in Peace and War '. As Mr. Spiller occupied the chair for the next four years the next presidential address was in 1920 by Mr. A. C. Campion. It was entitled ' Orthodontics, a Study in Six Dimensions '. This was followed in 1921 by Mr. Lewen Payne's address entitled ' Orthodontics '. In 1922 it seems a suitable title could not be found but since that time it has been the custom to indicate the theme of the address by giving it a suitable title.

The habit of including one or more scientific papers on the same agenda as the presidential address persisted for many years. Even as late as 1937 the presidential address was preceded by a short communication by Mr. Russell Marsh entitled ' The Six-year-old Molar '. On this occasion the address which followed occupies thirty-eight pages of the transactions.

Last year our president set a new fashion by giving his address a title which was a quotation from the best selling book of all time.

This year I felt I could not do better than imitate his example, so I have chosen a title from another best seller.

When the noble but melancholic Prince of Denmark said ' There's a divinity that shapes our ends, rough hew them how we will ', he was of course referring to the destiny of man rather than the physical properties of the individual, but it does nevertheless contain a considerable element of truth, which I thought might be profitable to explore, on the widest possible basis.

First of all let us take a closer look at the problems of heredity and how they may affect occlusion. There are many erroneous beliefs about the effect of the twin rolls of heredity and environment on the development of an individual. Some people believe that hereditary traits or diseases are an inescapable fate and have to be endured because they are untreatable, whilst non-hereditary traits can usually be successfully treated. Members of the medical profession know this to be nonsense and, of course, members of the public are beginning to realize this also. If a woman does not like the colour or straightness of her hair she does not have to be told the remedy, nor does she have to be told what to do about her child's irregular teeth, or so we hope.

Hereditary disease, however, is not so well understood. Here the effect of the disease-producing gene will depend on whether it is fully penetrant or not. For example, the gene causing retinoblastoma is dominant and fully penetrant and thus will always manifest itself. This formerly lethal disease can now be treated by radiation but this leads to blindness. On the other hand we have the hereditary disease of diabetes which is caused by a gene which is not fully penetrant. If this disease develops it can be successfully treated but there are many people having this harmful gene who are, in fact, normal and healthy and have not developed the disease. The conditions which bring about this fortunate state of affairs are still not fully understood but environment plays a large part.

Whilst on the subject of genetics it is interesting to note that children are more likely to resemble their grandparents than their parents. This is a fact that is often overlooked or forgotten because we learn biology so early in our training and therefore have plenty of time to forget the details.

The details, however, are important and I hope those of you that remember them will not mind if I refresh the memories of the others. The production of the gametes is by a process known as meiosis in which crossing-over of the chromosomes occurs and then a reduction in their number takes place.

Presidential Address given at the meeting held on 11 January, 1965.

It will be seen from *Fig.* 1 that the process of meiosis is in two main phases. During the first phase the chromosomes duplicate themselves so that there are four chromatids. Two of the chromatids then go through a process of crossing-over and two remain unchanged. At the end of

In the next generation it is obvious that the grandchildren will, on average, have cells containing 50 per cent of their chromosomes derived unchanged from their grandparents and 50 per cent a mixture of either pair of grandparents. As they will all have an equal chance of inheritance

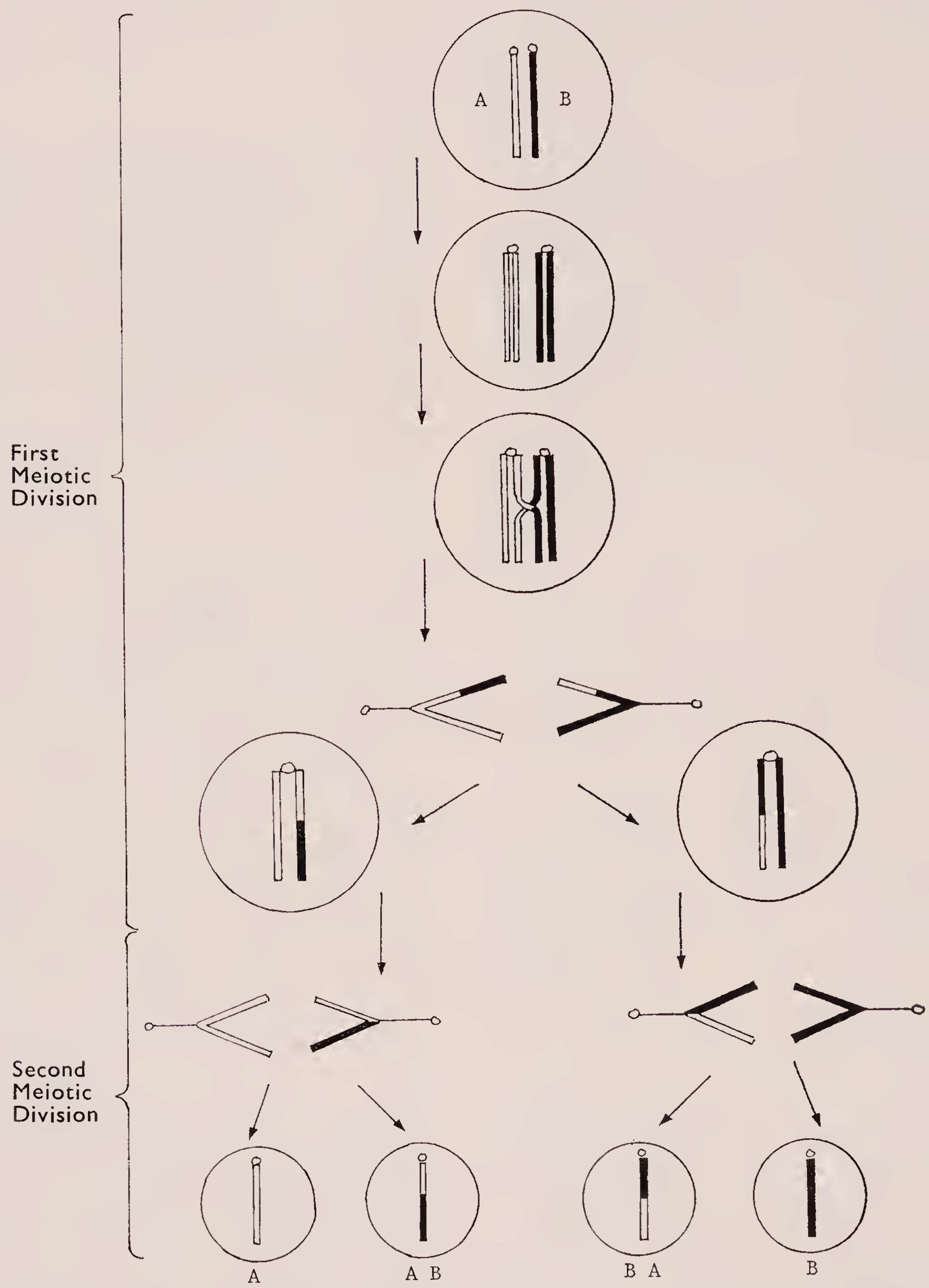

Fig. 1.—The stages of meiotic cell division. (*After Altenberg.*) First stage shows diagrammatically how crossing-over occurs and results in two cells in which either A or B chromosome is reduced. Second stage shows how four gametes are produced from the single original cell. Two of the gametes, A and B, are identical with those of the parents and with those of the grandparents and two, AB, BA, are unlike those of the parents but are a mixture of those of the grandparents. In the female, only one of the four gametes survives.

the first phase we have two diploid cells each containing, on average, 50 per cent of unchanged chromosomes and 50 per cent of mixed chromosomes. In the second stage these two cells divide again to form four gametes which will have 25 per cent of the chromosomes identical with the father, 25 per cent identical with the mother and 50 per cent mixed chromosomes.

they will, on average, have 50 per cent of chromosomes similar to one another.

It follows, therefore, that any research involving families and hereditary characteristics, must take account of the grandparents and the sibs of the individual. Often the grandparents may be dead or have lost all or most of their teeth and so be of no value to the investigation, so that it is

then necessary to wait for the next generation to be born. This, of course, is very laborious and time consuming, a problem of which I shall have more to say later.

One must also bear in mind the fact that a man has only one X chromosome which he inherits from his mother so that any characteristics that it contains whether they be dominant or recessive will always manifest themselves. The son in consequence being a little more like his mother and a little less like his father. The same is not true for girls as they have two X chromosomes.

Another reason that children are more likely to resemble their grandparents is that often quite noticeable characteristics may be due to recessive genes which can only show in the first generation if both parents possess the same gene.

The snub nose, for example, is the effect of a recessive gene and is only likely to occur in the first generation if both parents possess this gene. If only one parent possesses this gene then none of the children will have snub noses.

Some of you may wonder how one can be so sure that the chromatids, of the first cell division in meiosis, can always be exact replicas of the original chromosome.

The answer to this problem was discovered by Watson and Crick (1953) who first described the double chain of a substance called deoxyribonucleic acid or DNA. The diagram shows in a simplified manner the construction of one of these chains which consist of a sugar, a phosphoric acid radicle, and a nitrogen base.

$$\begin{array}{ccccc} -O_3HPO- & \text{Sugar} & -O_3HPO- & \text{Sugar} & -O_3HPO- \\ & | & & | & \longrightarrow \\ & \text{Nitrogen base} & & \text{Nitrogen base} & \end{array}$$

The nitrogen base can be of two types, either a purine, namely adenine or guanine, or a pyrimidine, namely cytosine or thyamine.

The chromosomes consist of a double DNA chain arranged in a spiral and when the nitrogen base on one chain is a purine like adenine the other chain always has a pyrimidine, namely thyamine, and when guanine occurs it always pairs with cytosine. So we can get a chain:

$$\begin{array}{cccccccccc} T & G & C & A & G & G & C & T & \\ | & | & | & | & | & | & | & | & \longrightarrow \\ A & C & G & T & C & C & G & A & \end{array}$$

Purines < Adenine, Guanine

Pyrimidine < Cytosine, Thyamine

When the chromosome splits each half makes a replica of its former partner so that two identical chromatids are formed.

At one time it was thought that any character or trait could be explained by heredity or environment but it is now known that these two influences are not mutually exclusive but that the various characters or traits in an individual are the result or product of a number of genetic and environmental influences (Kalmus, 1964).

Some factors are, of course, little affected by environment, eye colour or finger prints are obvious examples but others, such as rate of growth, are very much affected, particularly in farm animals. Studies of identical twins have served to underline this point. All of us have seen many pairs of identical twins and found it very difficult to distinguish between them. It is unfortunate for us that their infant nurture is often very similar and so does not lead to differences but sometimes identical twins go to different foster parents and then differences do arise. Sometimes differences occur even in what appears to be the same environment. Identical twins have been born, only one of which has a cleft palate or hare-lip; in fact, I believe it is less common for both identical twins to have cleft palates. Club-foot on the other hand occurs in both identical twins in about 25 per cent of cases.

When one studies the effect of environment on the individual, it soon becomes evident that the periods of rapid growth are more susceptible to change, particularly the early formative years. In this connexion it is a pity that more is not known about the first environment, in the mother's womb. I am sure that this would be a most rewarding line of research. It would be interesting to discover if the first child suffers more from compression due to tight abdominal muscles than the second child who is following a path already pioneered by another. In a series of interesting experiments with horses, Shetland ponies were crossed with large Shire horses. It was found that the size of the foal was dependant on which way the cross was made. The Shetland mare produced a much smaller foal than the Shire mare. Genetically the foals had the same size-determining genes but only in the larger womb of the Shire mare could they develop to the full extent (Auerbach, 1962).

Experiments such as these would lead one to think that something might be done to improve the human race if better conditions could be obtained in utero. In fact, some such experiments are being carried out in South Africa, where expectant mothers are encouraged to relax for a few hours each day in a sort of decompression chamber. The abdomen is enclosed in an airtight and rigid frame and the pressure is reduced. This, it is claimed, increases the blood-flow to the placenta and raises the oxygen content of the foetal blood. More than 200 children have been born to mothers who have followed this routine and the results justify the continuation of the experiment. The children mature more rapidly, both physically and mentally, and seem much healthier. The experiment was part of an

investigation into the causes of cerebral palsy in the newborn and so far no cases of palsy have been recorded amongst these children. As the oldest of these children is only just over 2 years old, no report on the jaw or tooth development is yet available, but it might prove very interesting.

The relative effects of heredity and environment on any particular structure depends on what aspect one is observing. For instance body height has been shown to be mainly determined by heredity but body weight can be influenced considerably by environment. From this it can be inferred that the jaw size is so controlled by heredity as to be unchanged by environment and this is probably true, also, of jaw shape and relationship although one might think that these might be capable of some modification.

Much less is known about muscles and muscle action and to what extent they are controlled by heredity. Like skeletal patterns, the muscular and neuromuscular systems appear to be patterned but, unlike the skeletal system, they are capable of making rapid adjustments to any great change in bodily needs or in the interest of survival or protection. What seems certain is that the genotype will determine the limits within which the individual can develop and also the facility with which any individual can achieve the possible limit.

Newman, Freeman, and Holtzinger (1937) in an interesting study of 50 pairs of identical twins, 50 pairs of fraternal twins, and 19 pairs of separated identical twins, have shown that certain hereditary features are scarcely altered by environment whilst others are altered a great deal. Physical characteristics are affected least, intelligence more, educational achievements still more, and personality and temperament most.

In the cases of the separated twins, the temperament and neurotic disposition varied in most of the cases and it varied most where the difference in environment was greatest. In one pair, for example, who grew up quite near to each other, one in town and one on a farm, the country twin was more muscular, had larger hands and feet and was more phlegmatic whilst the town twin was less muscular, 28 pounds lighter, and more excitable. Unfortunately the information given about the twins' teeth is lacking in detail and often limited to saying that they are very similar or nearly identical.

At a meeting of this Society in 1955 Mr. L. Leech described a pair of identical twin girls one of whom was Angle's Class II, division 1 and one Angle's Class II, division 2. The case reports of these children showed no difference in habits or medical history except that one was left handed and the other right handed and the conclusion reached was that although the skeletal and soft-tissue size and shape were almost exactly the same, the behaviour of the muscles appeared to be different. Holly Broadbent (1937) also described a pair of identical twin boys who showed differences but in his twins the rates of growth were different. The one twin was much healthier and more robust than the other and had escaped nearly all the childhood diseases that had befallen his less fortunate brother, including typhoid fever at 9 years and measles at 10 years.

The first cephalometric tracings, at $11\frac{1}{2}$ years of age, show a marked lack of forward growth of both jaws of the less fortunate twin and the teeth showed much more crowding. Both twins were skeletal Class I and Angle's Class I, and the healthy twin developed a normal occlusion without the assistance of orthodontic treatment. The less fortunate twin had treatment started at the age of $12\frac{1}{2}$ and although he achieved a normal occlusion, it was evident at 16 years that the third permanent molars would not have sufficient room to erupt and even the second mandibular molars appeared to have insufficient room to erupt completely.

In 1930, Mr. Packham described a pair of identical twin girls, one of whom had 'thriven' from the first and the other had been sickly. They had continued this way for 2 years and then the weaker one began to pick up and overtook her sister. At the age of 13 years, the fitter twin had better arch development and the one who had shown early weakness 'showed definite signs of overcrowding and under-development of the front part of the maxilla'. This, in spite of the fact that the twins were of equal height and weight. In the past thirty years a number of other cases of identical twins have been brought to the notice of the Society by its members, either to demonstrate an inherited defect or to show a difference caused by environment.

Little is known about the inheritance of dental defects except in a few special cases such as a hare-lip and cleft palate. They are often hereditary but may also occur as a developmental accident. What is perhaps rather disturbing is that the incidence of hare-lip and cleft palate is now nearly twice as great as it was one hundred years ago, a fact that must be considered in relation to the advances in surgical and postoperative procedures in saving life and improving marital chances.

The inheritance of other abnormal dental characteristics, such as a small lower jaw, seems to be due to a gene which cannot be called recessive even if the effect it produces on the chin merits this term. One sees so many parents with a typical Class II, division 1 occlusion who have children with the same defect that the conclusion seems obvious. It would, however, be very interesting and instructive to obtain pedigrees of all the main types of malocclusion in much the same way as has been done in respect to the 'Hapsburg' chin.

When one passes from the realm of form to that of function and behaviour one gets the

feeling that the world of genetic fact has been left behind and that a world of genetic fantasy has taken its place. Part of the trouble lies in the meaning of words because science borrows ordinary words which may have a special meaning and it alters the meaning just a little till in the course of time it acquires a new meaning altogether.

A lawyer will talk about inheritance of properties and will take steps to prevent the beneficiary from losing or otherwise being deprived of his inheritance. The biologist talks of inheritance as a characteristic, such as red hair or blue eyes, which has been handed down from a parent to his offspring and which cannot be taken away (Kalmus, 1964). Orthodontists are often very remiss in respect of words and are sometimes guilty of using them without regard to their proper meaning. One glaring example is the word ‘ morphology ’ which has often been used instead of the perfectly good word ‘ shape ’. I am glad to see that this is happening much less in the last few years. The immediate past president Professor Tulley (1964) made a plea in his inaugural address for more caution to be exercised in the use of the word ‘ diagnosis ’ when we really mean ‘ case assessment ’. May I, in turn, suggest that the word ‘ endogenous ’ is much too frequently used. One has the feeling that every time an orthodontist is baffled by a case he explains it as being due to endogenous behaviour. All his failures in treatment he blames not on himself but on some endogenous factor and here he resembles our noble but fatalistic Prince Hamlet.

We have learnt how to estimate skeletal defects which disturb the occlusion and we have learnt how to compromise with nature to make these defects less obvious. We can bring the teeth into an acceptable occlusion but we have not yet solved the problems of muscle behaviour. There is overwhelming evidence that genetic factors have their influence in all spheres of life, including human temperaments, but the solution to our problems lies in a correct assessment of the interaction of both environmental and genetic causes. Medicine has problems, such as duodenal ulcer or rheumatoid arthritis, both of which have a genetic background and both exhibit an environment which includes mental and physical stresses (Clarke, 1964). It is just these stresses to which the human race is now being subjected in ever-increasing measure that cause our muscles to behave in ways we find difficult to understand. Among muscles which are most affected are, quite naturally, the muscles of expression and these, of course, have considerable effect on the incisor teeth. Often we would like to change the behaviour patterns of the lips or tongue and sometimes we are successful. When we are successful it is almost certainly because the existing behaviour was learnt and we have restored it to the inherited pattern. If we fail we are apt to say it is due to endogenous factors such as a tongue thrust but it is just as likely to be due to some other causes we do not yet understand.

So often one hears it said that people have lost the art of relaxation; Yogi and such methods are invoked to help us. Never before has the consumption of sedatives, relaxants, and sleeping pills been so widespread and so necessary as it is today. What is more disturbing is that the pace of modern life has its impact on our children very early in their school life and the tendency is to make it earlier still. No one knows what effect this will eventually have on the occlusion of the teeth. It may be that the gradual change from a nearly edge-to-edge occlusion in the early Anglo-Saxon to the close bite which is so frequently seen today may be due to such causes.

The study of behaviour is a difficult field of research because there are so many imponderables but there are many ways in which the problems can be tackled. To the clinician psychology is one of the first avenues to be explored and to the research department electromyography would seem to be the most fruitful line of enquiry.

Electromyography is most useful in enabling us to understand normal activity in muscles so that abnormal patterns of behaviour can be detected and analysed and in many cases suitable treatment instituted but it seldom helps us to build up the complete picture of the events which culminated in the abnormal behaviour in question.

Psychology on the other hand is quite good at telling us how this or that may have originated but we are naturally suspicious and sceptical because we often find the explanations embarrassing, especially when the word sex crops up, as it nearly always does. Whatever we may feel about psychological explanations, there is no doubt that we shall have to come to terms with them sooner or later, if we are to begin to understand many of the conditions we observe today.

Habits, such as digit sucking, tooth-apart swallowing, and tongue thrusting, are all examples of the instinctive behaviour necessary for survival, which have become exaggerated and indulged by postnatal environment but may also have a genetic background. The only connexion these habits have with sex is that both spring from the same basic necessity for the survival of the individual and the race.

To the newborn child the only pleasure known is that of sucking in the warm sweet life-giving fluid that will satisfy the uncomfortable feeling of an empty stomach and digit sucking is a pleasurable reminder if not a substitute for this. It is, however, one of the failings of the human race that it tends to self indulgence, whether it be in

the pleasure of thumb sucking, cigarette smoking, alcohol, or sex.

The human race is not alone in indulging these excesses because it has been observed that animals in captivity, living as they do in a rather boring man-made welfare state also develop habits. Monkeys have been observed in the London Zoo sucking fingers or thumbs and chimpanzees are very fond of cigarettes (Morris, 1963).

The pleasure of thumb sucking is derived from the sensation of the thumb touching the palate and from the tongue having something with which to play. The rest of the pleasure is supplied by the imagination, a quality which is super-abundant in children. Tooth-apart swallowing and tongue thrusting are usually seen in individuals who have not learned the more sophisticated behaviour which characterizes the normal adult. It is probable that there is a genetic background to this type of behaviour which makes some people less easily adaptive than others but it is also certain that infant nurture plays a big part. The practice of giving homogenized baby foods, potatoes mashed in gravy, etc., cannot help a child to learn how to cope with hard and fibrous foods such as it will experience in later life.

The broad picture that emerges from the discussion is that the genetic inheritance gives the individual a physical potential which includes a certain basic, instinctive behaviour. For the first few weeks after birth the infant survives because of its instinctive behaviour but as time goes on intelligence, which is also inherited, enables it to cope with various problems that arise. The type of problem that will arise will depend on environment so that if the child is born in Germany it will learn to speak German, or if in China, Chinese (Kalmus, 1964). Even the type of language will depend on the local environment and much the same can be said of other problems. One of the first major problems facing the child is learning to sit up and then to walk and with these accomplishments come other problems. One of these problems is how to keep the mouth shut. When you lie down there is very little problem but as soon as you assume a vertical posture the lower jaw tends to sag open and definite muscle action is necessary to counter this tendency. Contraction of such muscles as the masseter and temporalis will achieve this object and can be tiring but fortunately the individual finds that by closing the oral cavity anteriorly with the lips and posteriorly with the tongue and soft palate, a partial vacuum can be created. This will cause the greater atmospheric pressure outside to help to support the mandible. The degree to which this manœuvre is carried out will vary very much from one individual to another and indeed some young people seem to give up the struggle altogether.

It will therefore be seen that there remains a possibility of a wide variation in adaptive behaviour which can have a profound influence on the arrangement of teeth. We assume that the child who goes around with his mouth sagging open will have a narrow upper arch and protruding upper incisors whilst the lower arch will be relatively normal. What of the child who creates an excessive negative pressure in his mouth so that the atmosphere will support his mandible? Will he have arches which are flattened in the incisor region and broad in the molar region because the tongue is pulled back from the incisors and supports only the molars? Here again there is a very real need for some research so that a better understanding is achieved.

With the greatly improved facilities and new electronic apparatus at our disposal, the investigation of minute pressure differences can now be attempted without too much difficulty, in much the same way as a surgeon can measure changes in blood-pressure in the heart.

A fascinating problem of which we know very little is that of missing teeth. Why should a child have a full set of teeth on one side of the mouth and yet fail to develop one or more teeth on the other side? If this were an hereditary effect it would be expected that it would be symmetrical, unless it were due to a gene that is not fully penetrant, in which case we must look for the environmental factor that makes it evident. Some light is thrown on this subject by Gruneberg, in a paper read before this Society in 1949. In experimental breeding of mice a pure strain, CBA, was produced which often produced offspring with missing third molar teeth. These teeth were missing more frequently in the lower jaw. Out of 61 affected animals there were 79 lower and only 10 upper teeth missing. This work was incomplete when he delivered his paper but he was able to say that the frequency of the occurrence of missing teeth was such that it was very unlikely to be genetic because some litters were affected and others were not affected. He summed up the situation by observing that the animals of the pure CBA line are all alike in having a tendency for about 16 per cent of the animals to have some missing third molar teeth as a result of an intra-uterine accident which happens in some pregnancies but not in others.

Another problem is that of misplaced teeth. Why are they usually unilateral and how, for example, does an upper canine tooth become displaced from its developmental position high up on the labial side of the maxilla and eventually lie horizontally in the palate with its crown in close relation to the root of the lateral?

The larger problems in orthodontics which are caused by skeletal inbalance are better understood and various methods of treatment have

been devised which are for the most part very satisfactory. The problems of overcrowding, whether it be with normal or abnormal skeletal relationship, are also well understood but I feel that a little more could be done in those cases of potential overcrowding which can be made so much worse by neglect or ill-advised dental treatment. I do not wish to say much about this subject in this address except to remark that I am very pleased to see that dentistry for children is at last taking its rightful place in our dental schools.

It is high time that it took pride of place and that it should be possible for every child to be examined at an early age and an assessment of his dental future be made which will enable him to enjoy a dental fitness which has not been possible hitherto.

Whilst on the subject of our dental schools let me say how very gratifying it is to see that they are, at last, being brought up to date. The first of the new dental schools has just been completed in Birmingham and the members of this Society will have an opportunity of judging for themselves the great advances that have been made when they are the guests of the University of Birmingham at the end of April this year. Other dental schools are also being rebuilt or having large additions and it is very good to see that an enlightened attitude on the part of the Ministry of Health and the University Grants Committee has enabled planned research to become a major function of medical and dental schools in this country. Much of the research in orthodontics is of a long-term nature and is very involved. This Society is very anxious to foster these research projects and in 1963 started a research session as a preliminary to the Country Meeting. The first of these meetings was limited to people who made special application to attend it but it was such a success that in 1964 it was thrown open to all our members. As the facilities for research grow this aspect of the Society's activities must also grow and I would like to see the Society itself take a more active interest.

Some of the problems which have to be solved will take a long time and require a lot of research over the whole country. The complete examination of 500 or 1000 sets of identical twins to estimate all the genetic and environmental factors which cause similarity or differences in their occlusion and muscular behaviour would occupy more than a life time of study for one man. With a joint effort of a team of workers from different schools this problem could be cut to life size proportions. The Society could help by appointing a research committee consisting of senior members of our various dental schools who could meet and decide what outstanding questions in orthodontics need to be answered and what kind of research would be necessary to answer them. They might even compile a list of priorities so that emphasis could be put on what they might consider to be the most urgent problems. And finally they might, with the help of the Society, try to persuade research students in our different schools to work together in collecting all the necessary data and pooling their resources in order to arrive at a successful conclusion in the shortest possible time. You may, at the moment, think that it is presumptuous of me to make a suggestion of this sort but I have the feeling that most of the short-term research projects will soon have been completed and only the long-term ones remain.

The idea of the Society acting as a central organizing body is not so novel or revolutionary as it may sound. In 1947, Professor Harris, in the first Northcroft Memorial Lecture, suggested that there ought to be such a body but he did not go so far as to urge the Society to form one. He also suggested that ' detailed studies of the dental anatomy of identical twins and of selected families should be undertaken on the largest practicable scale '. Eighteen years have passed and we have done very little to show our appreciation of this very valuable advice.

If our more difficult and lengthy research activities are not guided by a central body there is always a danger that they will get lost in their own ramifications or die of starvation through lack of encouragement. The very name of our Society makes it incumbent on us to promote research and study in orthodontics and this is the object of its being. In the past it has proved an excellent sounding board for its members who have come forward and contributed to our meetings, have given us the benefit of their experience, and have shown us the results of painstaking research over many years. It has also undertaken projects on behalf of its members, for example, the report on Postgraduate Education, 1944, and the report on Nomenclature, 1927. I urge you, therefore, to think most seriously on this and set aside all thoughts of personal glory. To find satisfaction in the profession of your choice by being content to serve as a member of a team for the benefit of all.

Whilst on the subject of research let us not be too specialized and too conservative in our outlook. As our problems become more difficult we need a much broader and much deeper knowledge of allied subjects, particularly physiology. When it comes to muscle behaviour and neuromuscular activity, there are very few of us who do not regret our limited knowledge. We should not be too proud to enlist the help of experts in the particular field in which we are interested and encourage them to take an active interest in our research activities.

We must remember that experts in clinical research, be they physiologists, biochemists, geneticists, biologists, or pathologists, all rely on the co-operation of practitioners of medicine or

dentistry for their most important sources of material for their studies.

The Society has already taken one big step in this direction when it instituted the Northcroft Memorial Lectures in 1947. The subject matter of these lectures is sometimes purely orthodontics but it has been your Council's policy to invite lecturers who are experts in other fields and can by their profound knowledge shed further light on some of our problems and we hope stimulate us to greater endeavours.

This address has concerned itself with problems of heredity and environment in the broadest possible terms and it is fitting therefore that it should consider how these two problems affect the Society itself. Like all good bodies with a lively and fertile clientele, it is only to be expected that other similar bodies should be born with similar characteristics which they inherit from the parent. With the more widespread knowledge and interest in orthodontics it is natural in regions remote from our headquarters that a desire and need for provincial orthodontic groups and societies should arise. Once the number of people interested in orthodontics is sufficient to sustain a regional Society of this kind it only remains for a few enthusiasts to organize them and a flourishing Society is born. The B.S.S.O. must, therefore, look on its offspring as a parent should and see that they receive the care and infant nurture that is due to them. Close links should be established so that a close knit and harmonious family relationship exists and just as the parent owes a duty to the child so does the child owe a filial duty to the parent. The parent must allow the child to have its freedom but the child should not try to usurp the position of the parent. This is a fundamental principle of any well organized Society.

In the next few years, therefore, it will be necessary for the B.S.S.O. to consider how this happy state of affairs can be brought about and how it can be maintained.

We must create a healthy climate where confidences and opinions can be freely expressed, discussions take place in quiet harmony, and trust and decisions made which will be of mutual benefit to all concerned.

We must look on these our children as mirrors of ourselves; any defects we observe in them we must be sure to avoid in ourselves and anything we observe that is good, we might do well to imitate.

Even as this new pattern of activity of the Society emerges let me sound a warning that we must be ever watchful that dental politics has no part in these activities. As a final note on this particular subject, may I remind you that when the B.S.S.O. was formed there were some who thought that it would draw off members and interest from the older existing Societies and they deplored this break-away Society. This led your first President in his address in 1908 (Badcock, 1908) to make the following observations: ' The British Society for the Study of Orthodontia is a spontaneous, natural, healthy, vigorous growth, a proof of vitality in the parent and a promise of added strength to the dental family. I believe that the older Societies will find that instead of sapping their vitality and diminishing their material, it will become an added store on which to draw '. Although I remind you of this some 57 years later the truth of his remarks has long been evident.

We must also take a close look at the evolutionary changes that are taking place in our teaching hospitals or schools as they are now called. When I was a student it was quite common for all the clinical teaching to be done by honorary dental surgeons who had high-class private practices. These same people made up the greater numbers of our Society and contributed nearly all the papers and communications which were read before it. These were quite naturally of an essentially practical and clinical nature and closely related to the problems of private practice. Gradually, however, this happy breed of man is disappearing and the full-time University lecturer is taking his place. These are also members of our Society and contribute generously to our meetings, but these contributions are often of a highly scientific nature, contain a lot of data which is technical or statistical and are in consequence difficult to assimilate.

If this process continues much further we shall be in danger of becoming a society of orthodontic research and while research is a fundamental reason for our being, we must remember that the great majority of our members are general practitioners with a special knowledge of orthodontics. We must keep a proper balance in our programmes so that our meetings continue to be of the greatest possible value to the greatest number of members.

In order to do this it may be necessary to extend the scope of the Country Meeting, which after this year will also be the Annual General Meeting, so that one whole day is set aside for papers on research projects. This would make more space available on the occasions of our ordinary meetings for casual communications and papers of a more practical nature. If such an arrangement is made I hope that the research papers will be circulated before the meeting so that the full value of the occasion can be realized.

In conclusion may I repeat that there are many problems in orthodontics which need to be solved and some of these call for a much closer degree of co-operation from research workers with the same interests. Particularly the problems associated with heredity and environment need further investigation and greater use should be made of the unique opportunity that nature offers us in the form of identical twins. The study of

identical twins calls for very close co-operation not only of orthodontists but of specialists in other disciplines. If we wish to broaden our horizons and get a little nearer to the fundamental truths we have to realize the limitations of our own attainments and enlist the help of our colleagues who have specialized knowledge in the basic biological sciences.

The study of prenatal and infant environmental influences should also be very rewarding and shed light on many of our problems and this again is something which the orthodontist cannot undertake satisfactorily on his own. Studies of this sort should provide most of the answers to problems of growth and neuromuscular behaviour and so give us a better understanding of what is required in orthodontic treatment.

Finally, I repeat that this Society has a duty to foster and promote research by stimulating, encouraging, and co-ordinating the efforts of individuals throughout the length and breadth of the country and, at the same time, it must be ever mindful of the needs of the individual members of the Society. Let us have no illusions about our future development, it will depend on our own efforts and our Society will flourish in accordance with the zeal and foresight of its officers. We are living in times of great change and we ourselves have to make changes but let us take heart from the fact that we can shape our own ends and let us be sure that we shape them well.

BIBLIOGRAPHY

Altenberg, E. (1957), *Genetics*. London: Constable.

Auerbach, C. (1962), *Science of Genetics*. London: Hutchinson.

Badock, B. H. (1908), *Trans. Brit. Soc. Orthodont.*, 3.

Broadbent, B. H. (1937), *Angle Orthodont.*, **7**, 183.

Campion, A. C. (1920), *Trans. Brit. Soc. Orthodont.*, 69.

Clarke, C. A. (1964), *Genetics for the Clinician*. London: Blackwell.

Grunenberg, H. (1949), *Trans. Brit. Soc. Orthodont.*, 94.

Harris, J. E. (1947), *Ibid.*, 141.

Kalmus, H. (1964), *Genetics*. London: Heinemann.

Leech, H. L. (1955), *Trans. Brit. Soc. Orthodont.*, 38.

Marsh, L. R. (1937), *Ibid.*, 46.

Morris, D. (1963), personal communication.

Newman, H. H., Freeman, F. N., and Holtzinger, K. J. (1937), *Twins—A Study of Heredity and Environment*. Chicago: University Press.

Packham, A. L. (1930), *Trans. Brit. Soc. Orthodont.*, 100.

Payne, L. (1921), *Ibid.*, 5.

Spiller, J. E. (1916), *Ibid.*, 1.

Steadman, F. St. J. (1937), *Ibid.*, 9.

Tulley, W. J. (1964), *Dent, Practit.*, **15**, 36.

Watson, J. D., and Crick, F. H. (1953), *Cold Spr. Harb. Symp. quant. Biol.*, 18.

THE UNPREDICTABLE LOWER SECOND PREMOLAR?

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DURING an investigation into the long-term results of treatment several cases were found in which the behaviour of the lower second premolar was unexpected. Many senior members of this Society might have anticipated the results in these cases and their comments are welcomed.

Wilson (1952) showed 2 cases in which upper premolars erupted into good alinement without assistance, in spite of reduction of space following early loss. The first of these case reports shows a similar occurrence in the lower arch. The occlusion was Class II, Division 1 on a Skeletal II base.

Fig. 1 shows models spanning an interval of three years. The models on the left show almost complete closing of the lower left second deciduous molar space following its early loss. There is slight crowding of the lower incisors. In the discussion that followed Wilson's communication, it was suggested that the spontaneous disimpaction of the second premolar depended upon its eruption prior to the eruption of the second permanent molar. In this case the second permanent molar has already erupted on the left side, following early loss of the second deciduous molar, but, in spite of this, the lower left second premolar has disimpacted.

No lower appliance was used during this period but for the first nine months an upper appliance was used which carried an anterior bite plane. In the later models an increase in the lower incisor crowding can be seen. This is an all too frequent sequel to the reopening of lost premolar space. It occurs particularly when the unerupted premolar is vertical, rather than inclined lingually or buccally, and acts as a wedge between adjacent teeth during eruption.

The extraction of the lower second permanent molar has been suggested as one of the possible ways of avoiding this result. *Fig.* 2 shows the relevant area of the left lateral oblique radiographs in such a case.

Fig. 1.—Spontaneous eruption of impacted $\overline{|5}$ with increase in lower incisor crowding. (*Reproduced from* ' *A Manual of Practical Orthodontics* ', *2nd ed., by W. J. Tulley and A. C. Campbell, Bristol: John Wright.*)

Presented at the meeting held on 8 Feb., 1965.

At 11 years 4 months the lower second premolar is vertically impacted (*Fig.* 2A). There was a Class II, Division 1 occlusion on a mild Skeletal II base for which treatment commenced 2 months later with the extraction of the upper first and lower second permanent molars. *Fig.* 2B shows the condition at 13 years 4 months. The lower first and third molars are in much closer proximity. *Fig.* 2C, at 13 years 10 months, shows the lower second premolar erupted. Finally, at 16 years, *Fig.* 2D shows the lower third molar erupted. No lower appliance was used.

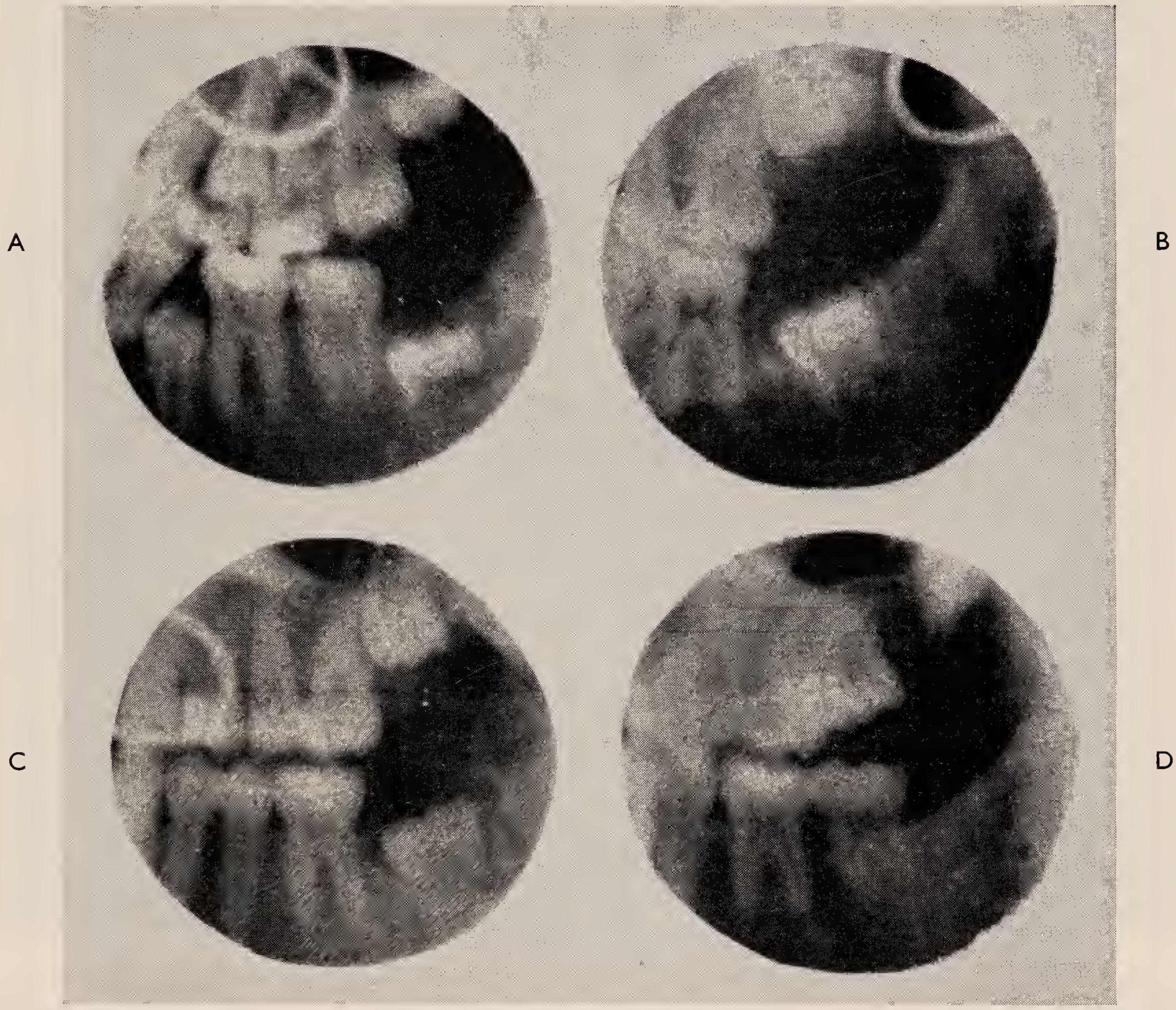


Fig. 2.—Stages in the eruption of $\overline{|5}$ and $\overline{|8}$ following extraction of $\overline{|7}$. A, 11 years 4 months; B, 13 years 4 months, C, 13 years 10 months; D, 16 years. No lower appliance used.

The extraction of lower permanent second molars is not an easy decision to make. A number of factors must be considered and the result cannot be assessed for 5–6 years. This is certainly one occasion where a little foresight would be very welcome.

The next case shows that inadequate space is not the only obstacle to the normal eruption of the lower second premolar. *Fig.* 3A shows the left lateral oblique radiograph of the patient aged 8 years 3 months. There was a Class II, Division 2 occlusion on a mild Skeletal II base. Both lower deciduous molars were extracted at about 6 years of age. The root formation of the lower second premolar is just beginning and appears abnormal.

Fig. 3B shows this region at 13 years 6 months. There is marked dilaceration of the root of the lower second premolar which is impacted between the first premolar and the first permanent molar. This impaction was partially relieved by the extraction of the lower second permanent molar the following year, as can be seen in *Fig.* 3C, showing the condition at 15 years 6 months. At this time a removable appliance was used for 4 months to move the first permanent molar distally to complete the disimpaction of the lower second premolar which erupted into occlusion at 16 years 6 months (*Fig.* 3D).

The possibility of poor root formation of the lower third molar is one of the disadvantages of treatment involving extraction of the lower second permanent molar. The extraction must be

carried out when only the crown of the third molar is formed. This case shows, however, that the third molar is not the only tooth to be considered in this regard. There was no crowding of the lower incisors initially, not has any occurred so far and the third molars are now explanation is that the loss of a distal contact for the crown of the second premolar allows it to lag behind while growth of the bone is carrying the root forward.

It has been suggested that this type of change in premolar position may be too rapid to result

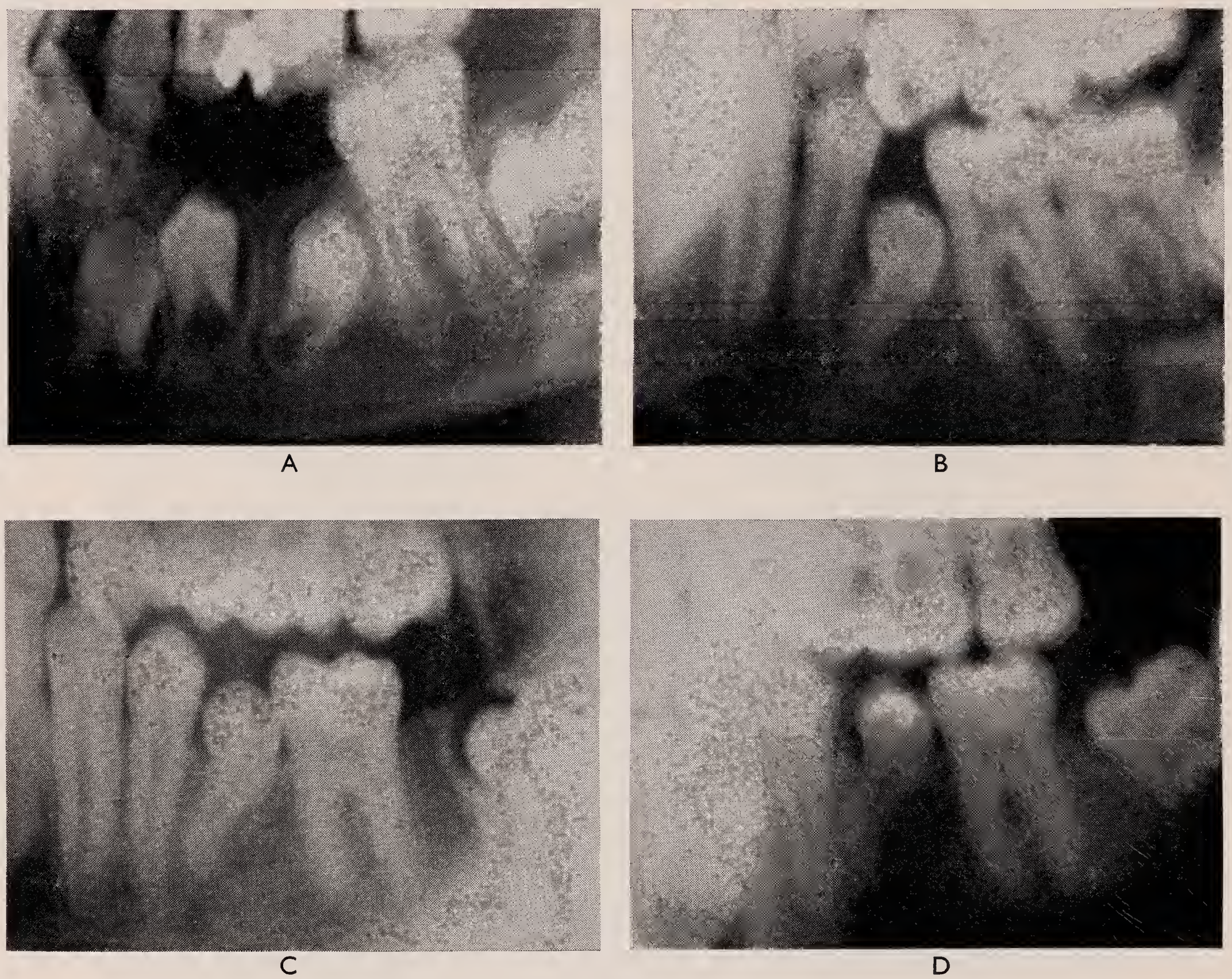


Fig. 3.—A, Unerupted $\overline{|45}$ at 8 years 3 months; B, Dilacerated and impacted $\overline{|5}$ at 13 years 6 months; C, Extraction of $\overline{|7}$ has partially relieved $\overline{|5}$ impaction at 15 years 6 months; D, $\overline{|5}$ in occlusion at 16 years 6 months.

erupting in good position a year after this last radiograph; but was it advisable to accommodate this lower second premolar?

The behaviour of the lower second premolar is quite different in the next case. The occlusion was Class III on a Skeletal III base. *Fig.* 4 shows the right and left lateral oblique radiographs of the patient aged 12 years. All first permanent molars had been extracted. The lower left second premolar is unerupted, situated centrally in the space between the first premolar and the second permanent molar (*Fig.* 4B).

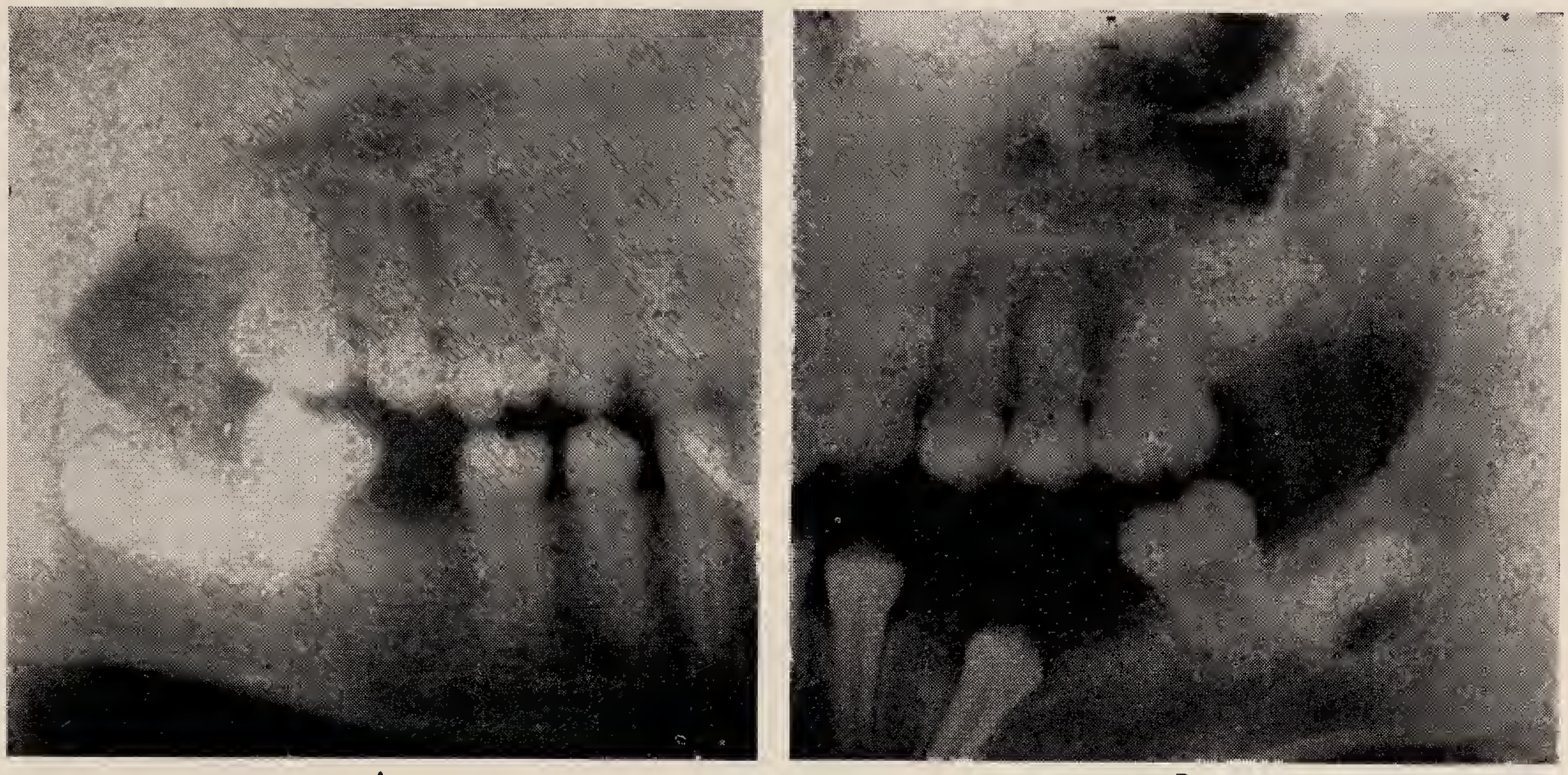
Fig. 5 shows intra-oral views of the change in axial inclination of the lower left second premolar over the period May, 1963, to January, 1965.

Friel (1945) states that in such cases the second premolar only looks as if it moves distally. His from growth alone. Rose (1958) suggests that the force of eruption modified by an atypical guide plane could cause the premolar to move distally. In this case the change in the position of the lower left second premolar confirmed on lateral skull radiographs over 14 months is evidence that some distal movement has occurred. Possibly the overlying plate of bone could provide the atypical guide plane for this movement. The next case has several features in common with this one.

The occlusion was also Class III on a Skeletal III base. There had been early loss of all lower deciduous molars, and in addition the lower left first permanent molar had been extracted.

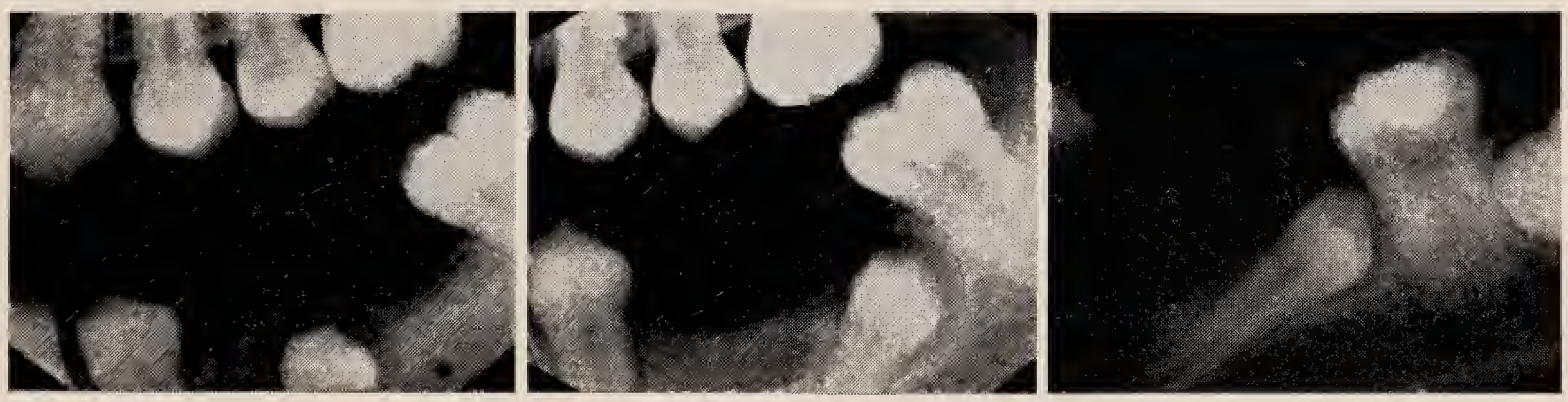
Fig. 6A shows the left lateral oblique radiograph at 9 years of age. The loss of the lower first

permanent molar has provided ample space for eruption of the lower premolars. *Fig.* 6B shows the same area when the patient was 11 years 6 months. The lower first premolar has erupted, but the lower second premolar has tilted distally into a horizontal position with its crown lying buccal to the roots of the lower second permanent molar where it could be palpated.



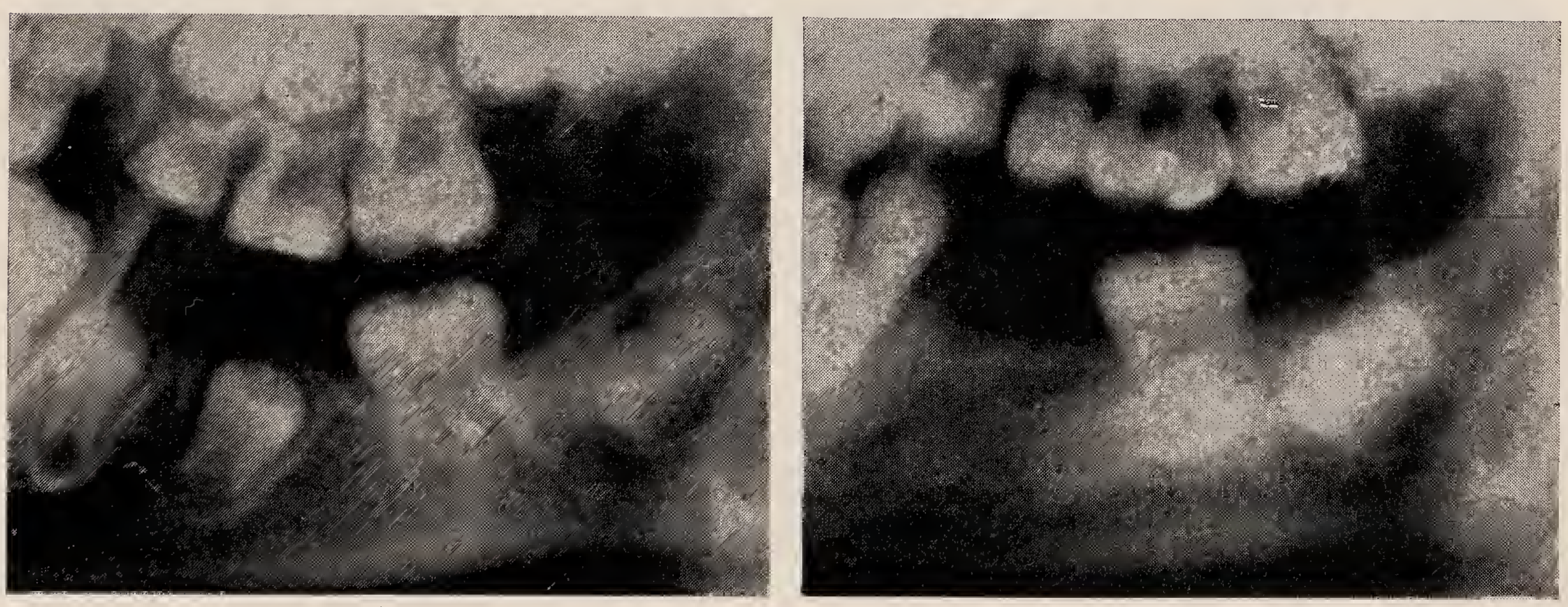
A B

Fig. 4.—$\frac{6|6}{6|6}$ extracted at 9 years. A, $\overline{5}|$ erupted and rotated; B, $|\overline{5}$ unerupted distally inclined at 12 years. (*By kind permission of F. Elston, Esq.*)



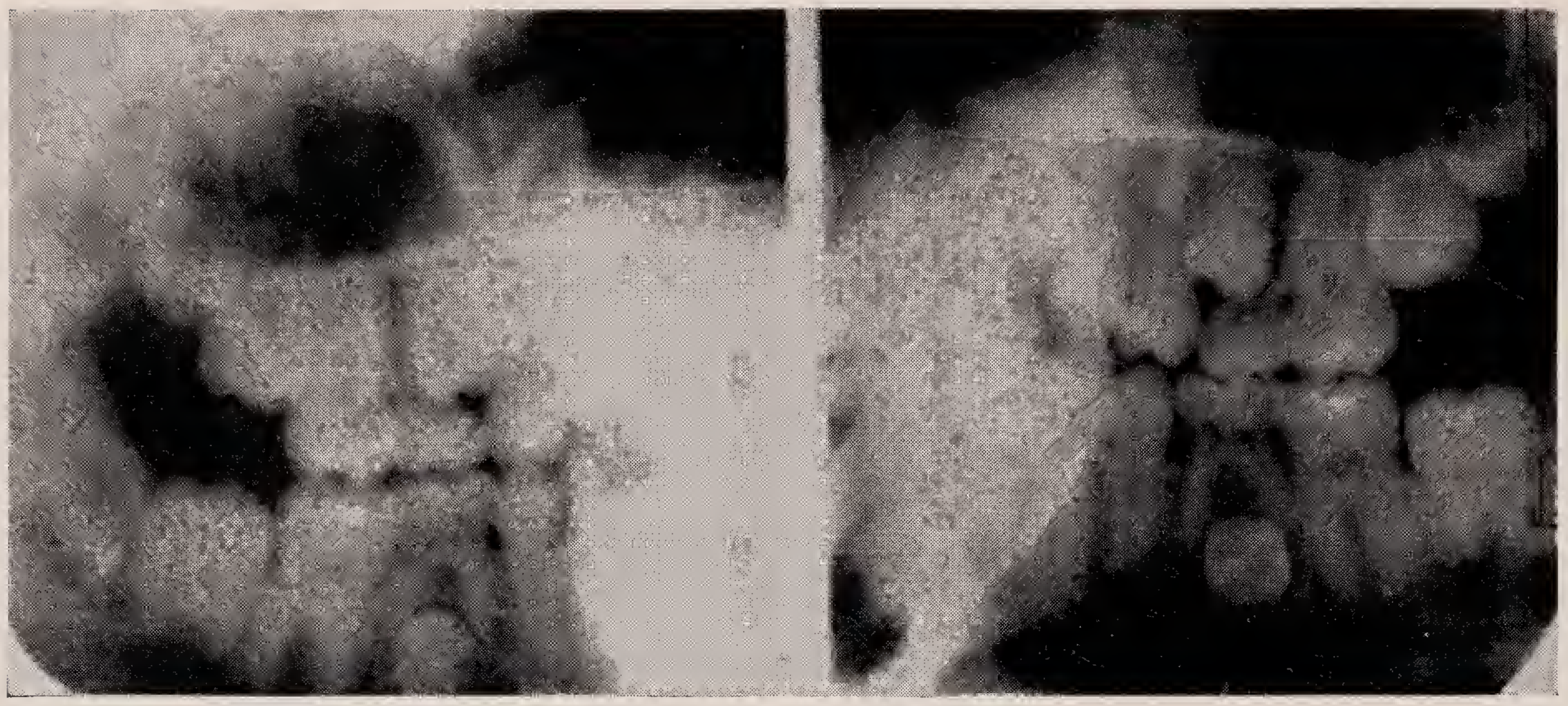
A B C

Fig. 5.—Change in position of $|\overline{5}$. A, 12 years; B, 13 years; C, 13 years 6 months.



A B

Fig. 6.—A, $|\overline{45}$ unerupted at 9 years, $|\overline{6}$ previously extracted; B, $|\overline{5}$ unerupted lying horizontally, buccal to $|\overline{7}$ at 11 years 6 months.



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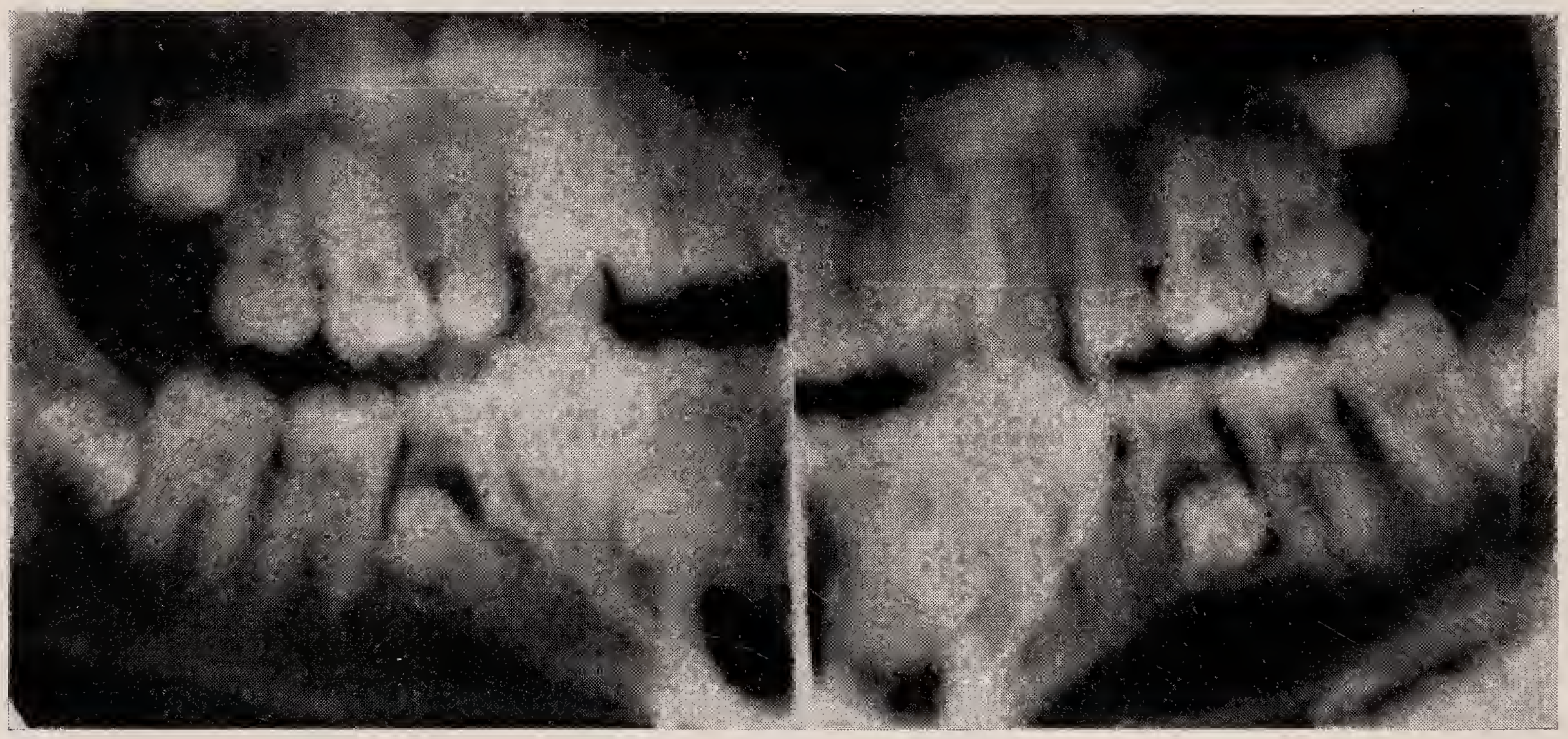

B

C

Fig. 7.—A, $\overline{5|5}$ lying unfavourably across the arch at 13 years 6 months; B, Change in inclination of $\overline{5|5}$ by 14 years 9 months when $\overline{E|E}$ were extracted; C, $\overline{5|5}$ erupting into occlusion at 15 years 6 months.

As in the last case, the lower second premolar approached the overlying outer plate of bone with a slight distal tilt, and perhaps the cause for its further distal movement was the same.

Rose (1962) quoted Hallett as saying, when looking at radiographs of premolars, ' that it was not sufficient to say all present, but all present and correct or not correct '. The problem is, when can one say the premolars are correct?

In the final case there was a Class II, Division 1 occlusion on a Skeletal II base. *Fig.* 7A shows the lateral oblique radiographs at 13 years 6 months. The lower second premolars are lying horizontally across the arch. *Fig.* 7B shows the change in inclination of the lower second premolars by the time the patient was 14 years 9 months. Clinically, the position of the crowns of these second premolars could be palpated lingually. At this time the lower second deciduous molars were extracted. *Fig.* 7C shows a further stage in the eruption of the lower second premolars into occlusion at 15 years 6 months.

The marked change in the axial inclination of the lower second premolars in this case demonstrates the amount of correction that can occur spontaneously. Because of their initial transverse position it cannot only be the adjacent teeth which act as the guide planes to such eruption.

It is hoped that these cases have been of interest and have shown why this communication was entitled ' The Unpredictable Lower Second Premolar? '

Acknowledgements

In conclusion I would like to thank Mr. R. E. Rix, Mr. K. E. Pringle, and Professor W. J. Tulley for permission to show cases under their care. I am very grateful to Professor Tulley for his guidance in preparing this paper, to Mr. B. A. Jones for the production of the illustrations, and to Mrs. Y. Rawlins for secretarial assistance.

REFERENCES

Friel, E. S. (1945), *Proc. R. Soc. Med.*, **38**, 456.
Rose, J. S. (1958), *Dent. Practit.*, **9**, 69.
— — (1962), *Ibid.*, **12**, 212.
Wilson, H. E. (1952), *Dent. Rec.*, **72**, 143.

DISCUSSION

The President pointed out that the lower incisors were crowded, and yet Mr. Cryer had been rather anxious about the premolars getting into occlusion. If upper premolars were taken out, this encourage the posterior teeth to drift forward, and if the upper posterior teeth drifted forward, the lowers were encouraged to drift forward, and quite often this led to lower incisor crowding.

Mr. J. S. Rose said that he was particularly interested in the premolar which moved distally and that a suggested explanation was that all teeth seemed to follow the path of eruption which was made easiest for them. The cases Mr. Cryer had shown, and the ones he himself had seen, had all been preceded by relatively early extraction of the deciduous molar. He thought that the bone over the crown of the second premolar became relatively sclerosed, and where there had been an extraction socket which would make the easiest path of eruption, the eruption potential would direct a premolar towards that distal side.

In relation to the suggestion that these teeth had actually grown distally, he had not been able to see on the screen where the apex of the second premolar was in relation to the first premolar. Had there been an increase in distance between their apices?

Mr. J. W. Softley said that, when he was a student, he was taught that early extraction of lower deciduous molars often made for delay in the eruption of the premolars, whereas early extraction of the uppers made for acceleration of eruption.

Secondly, although it certainly appeared as if there was very little bone above that premolar, did one know that the premolar was centrally placed in the alveolus? It might have been to one side or the other. He did not think that one could draw the conclusion from a single radiograph that the path of least resistance was distally.

Mr. D. H. Oliver said it seemed to him that this condition could be, and very often was, a direct result of early loss of deciduous molars or, on the other hand, of undue retention of a deciduous molar. There were also occasions when this kind of thing occurred for no apparent cause at all. Was this resulting from a form of bone dysplasia which was not yet understood?

Mr. T. Smith said that he had had a case many years ago where there were four such premolars in one mouth in the lower jaw and he had exposed them. What had surprised him was that there was no real occlusion in these teeth for a year or more afterwards. The gum went back round the cervical margin of the crown.

Mr. F. Allan said that he had often attempted to expose a premolar and put something round it to bring it out. He asked if anyone had any experience of the movement of these teeth that did not want to move.

Mr. B. C. Leighton referred to the President's remarks and said that he had had a case some years ago where the second premolars had erupted in the lower arch and caused crowding of the lower incisors. Subsequent removal of these premolars allowed the incisors to aline spontaneously.

In relation to the cases where a premolar had fallen over backwards and passed the second molar, he assumed that this was lingual. He had seen cases on two occasions like this, and in each of them he had the impression that the premolar was rotated in the same way as in Mr. Cryer's case. He wondered if this might be the factor which allowed these teeth to pass the second molar instead of being impacted on it.

Mr. G. A. Kerr said that in assessing the case for extraction of the first permanent molars, one factor he always looked for was whether the distal root of

the lower second deciduous molar absorbed more than the mesial root, and if the lower second premolar was lying beneath it. This was the sort of case where one often saw the lower second premolar moving distally, not necessarily falling over backwards, but it was an indication against removing the lower first molars.

The President said that it seemed to him that there were two kinds of problem here: those where a mouth was crowded, where there was lower incisor crowding and the second premolar either went lingually or forced its way in, and those where there was too much room. In the latter cases the orthodontists had made the problem for themselves.

Mr. Cryer, in reply, said that with regard to the President's query, this case was in fact treated some years ago, and the tendency then, in the treatment of Class II, Division 1 was that one rather left the lower arch alone and did the reduction in the upper arch to try to reduce the overjet. In this case, no extractions were planned in the lower arch at that stage, and he thought that it was hoped that the second premolar would come up lingually and then be taken out.

In the first case, he thought that if the first premolar had been taken out, the second premolar would have gone into its position and one would not have had an increase in crowding.

He was sure that Mr. Rose was right about teeth finding the easiest path. Mr. Rose had asked whether in fact this second premolar did actually move distally or only tilted distally. If one superimposed a lateral skull radiograph either on the symphysis or posterior border it certainly was distal movement of the tooth.

With regard to the speeding up of the eruption of the permanent teeth, which Mr. Softley had mentioned, he thought that it was a question of how near the surface the premolar was at the time of the early extraction of the deciduous molar.

On the question of exposing these teeth, it certainly appeared that if one uncovered the crown, considerable improvement occurred.

Mr. Allan asked about traction of these teeth. He thought that traction on these teeth, as on any other teeth was a risk as far as vitality was concerned. One would think that it was worth leaving it to nature to do, on the whole.

THE RELATION BETWEEN DENTAL MATURATION AND PHYSIOLOGICAL MATURITY

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INTRODUCTION

WHEN dealing with children it is essential that a clinician be aware whether or not his patients are developmentally advanced, normal, or retarded in relation to their chronological age. To the orthodontist, knowledge of a child's developmental dental status is of particular importance, timing being especially important in orthodontic diagnosis and treatment planning.

The precise developmental status, that is the degree of adult form which has been attained, can be estimated in several ways and expressed as an age. Namely: (1) Skeletal age; (2) Dental age; (3) Morphological age based on height, weight, etc.; (4) Secondary sex characteristic age.

Of these the most widely applied is that of skeletal age. Essentially it is a measure of the progress which the bones have made towards attaining adult form, as recorded radiographically. Each individual bone of the skeleton begins as a primary centre of ossification and subsequently passes through stages of general enlargement and shaping to reach its adult form. The sequence of appearance of the various ossification centres and their subsequent development is fairly constant between individuals. Standards of skeletal development of the hand and wrist have been prepared, and by reference to these standards it is possible to designate an individual as having attained a particular skeletal age.

It has been shown by Tanner (1955) that boys at the age of 14 years may be skeletally advanced or retarded by 2 years, i.e., of skeletal age 12 to 16 years. Such a variation in physiological age is of obvious importance to a clinician and must undoubtedly influence treatment. An orthodontist relying on chronological age as an indicator of his patient's ' age ' can thus only reckon within a 4-year physiological age period. However, it is not known whether or not the dentition is subject to a similar variation in relation to chronological age, and if so if it varies in unison with the skeletal system. Reports on the relationship between dental developmental status, as assessed from the degree of root formation, and skeletal maturity have been published by Lamons and Gray (1958), Hotz (1959), and Lauterstein (1961). The findings in these reports are not in full agreement. Lamons and Gray claim that skeletal and tooth development vary independently whilst the others claim a closer relationship. Further research is still required.

In attempts to estimate dental age, two methods have been developed. Firstly, various tooth development tables and charts have been published. The eariler of these, those by Legros and Magitot (1880), Pierce (1884), and Black (1908) may be disregarded as they are not compatible with present-day clinical findings. In 1935 Logan and Kronfeld published their standards of tooth development. Subsequently, several other charts have appeared, however, it seems that they have all been developed from Logan and Kronfeld's original. The material used to construct their chart consisted of twenty-five skulls. There was no separation of the sexes. The children from whom the skulls were obtained, having died at an early age, cannot be regarded as normal. On these grounds it is questionable whether Logan and Kronfeld's chart is of any reliable value.

Secondly, use has been made of the eruptive state of the dentition. It would appear from the considerable variation in eruption times of the teeth that actual eruption is by no means a constant reaction to a precise stimulus or stage of development. Then eruption comes under the influence of environmental factors such as crowding. Early loss of the deciduous predecessor or pathology and consequent delayed exfoliation can also cause delayed eruption of the permanent tooth. These are all factors beyond the endogenous growth potential of the individual, therefore a low correlation may be anticipated to exist between tooth eruption and somatic development. Thus tooth eruption cannot be regarded as a reliable measure of maturity. Gleiser and Hunt (1955) appear to be conscious of this weakness when in their survey of the mandibular first permanent molar they remark, ' the calcification of a tooth may be a more meaningful indication

Chapman Prize Essay presented at the meeting held on 8 February, 1965.

of somatic maturation than is its clinical emergence '.

With the above facts and the thoughts which they provoke in mind I decided to undertake a clinical study in order to determine the precise relationship which exists between the calcific development of the teeth as determined radiographically and general physiological maturation. Previous research, particularly that of Nicolson and Hanley (1953) has shown that skeletal age assessed from hand-wrist radiographs is a reliable means of assessing the developmental status of a child. It was thus decided to investigate the precise correlation which exists between dental and skeletal maturation.

REVIEW OF THE LITERATURE

There are very few reports in the literature which are directly concerned with the developmental relationship of the dentition and general somatic maturation. Following a review of this literature it is not possible to form a positive opinion of the relationship. Several reports have been published which appear to indicate the existence of a close inter-relation, whilst this is denied by other reports. Many reports use tooth eruption in the assessment of dental age. In assessing somatic development skeletal age, physique, and onset of puberty have been used. There are only three reports of studies in which the calcific development of the teeth has been studied in relation to skeletal maturity. The findings of these reports, which are at variance, will be discussed later.

In 1918 Spier, in association with Boas, showed that at all ages from 7 to 14 years boys with any given tooth already erupted were taller than those of the same age, but, as yet, without the tooth.

In 1931 Wallis demonstrated a similar relationship during the ages of 5 to 8 years, both for skeletal development and development of the dentition as assessed by eruption; taller children in each 6-monthly age-group were more advanced in ossification and had more teeth erupted than shorter children.

Catell (1928a, b) published a report entitled ' Dentition as a measure of Maturity '. She produced the correlations between dental age, as calculated from the total number of teeth erupted, and skeletal development. The correlation coefficients were:—

Age	*Boys*	*Girls*
6 years	0·45	0·16
$8\frac{1}{2}$ years	0·31	0·38
$10\frac{1}{2}$ years	0·24	0·14

In 1932 Todd quoted Broadbent as finding ' that a child which is retarded in skeletal growth is usually also retarded in tooth development '.

Shuttleworth, in 1939, showed that early maturing boys and girls were also advanced in dental development. He divided his subjects into three groups—early, medium, and late maturers—on the basis of their age at peak height velocity. The total number of teeth erupted at each age from 6 to 14 years was also plotted. In this way he showed that the early maturing types were ahead in dental development.

In 1953 Clements, Davies-Thomas, and Pickett noted that early eruption of the second molar is related to early puberty.

Sutow, Terasaki, and Owaha (1954) examined more than 1000 Japanese children between the ages of 7 and 14 years. They found that in each age-group those children having advanced skeletal development had a greater number of erupted permanent teeth.

In 1955 Krogman stated the view that dental age and skeletal age, both biological, are only moderately correlated. However, he added, ' Here again we may state the concept but await further elucidation as research progresses '.

In 1955 Gleiser and Hunt in their survey of the permanent mandibular first molar stated, ' on an individual basis the calcification of a tooth may be a more meaningful indication of somatic maturation than is its clinical emergence '.

In 1956 Sarnas remarked that ' some degree of relation seems to exist between skeletal and dental maturity, but how great is still largely not understood due to inexactness of methods in assessing dental maturity '.

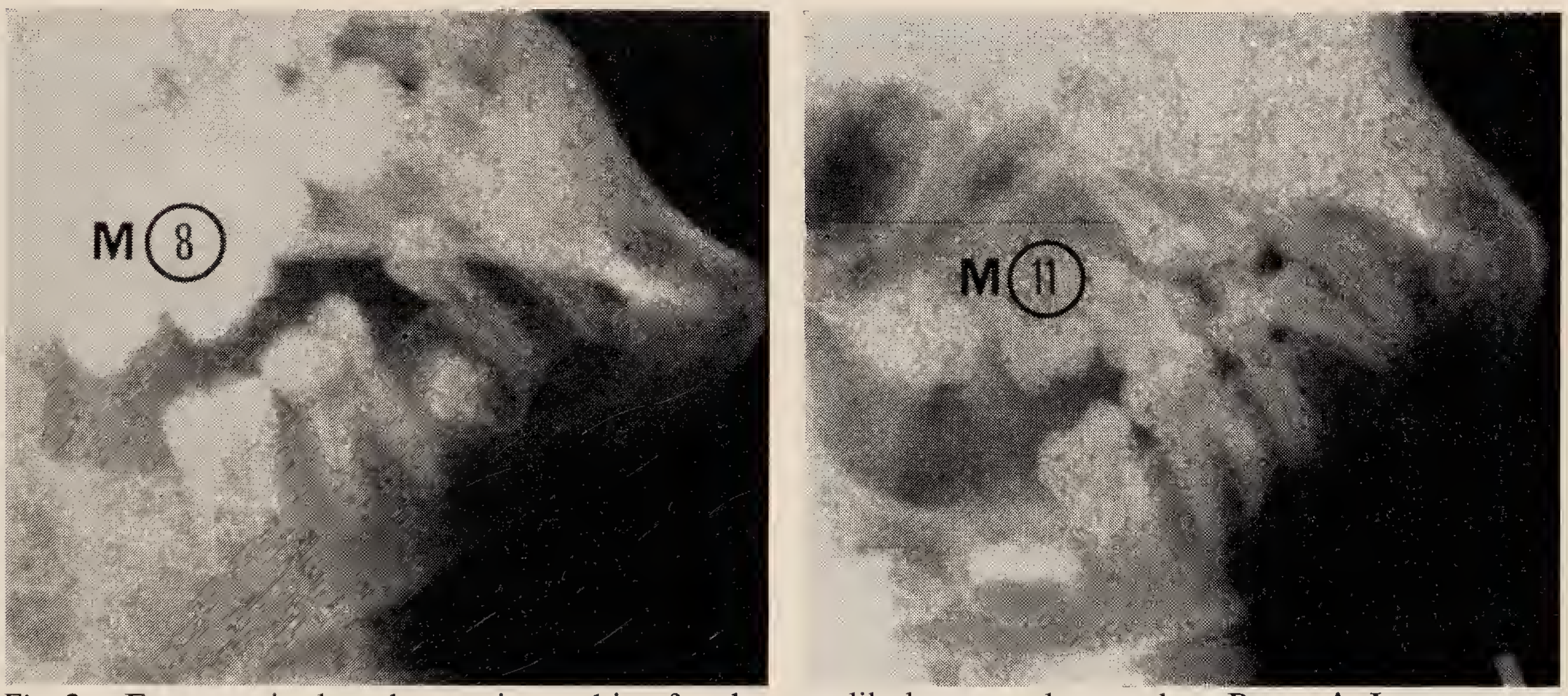
Lamons and Gray (1958) investigated the relationship to chronological age. Their material consisted of 147 records collected from twenty-five boys and thirty-six girls with an age range of 4 to 15 years. The study was of a longitudinal nature having one to six individual records from each child. In assessing dental age they used Massler and Schour's chart. Lamons and Gray found that chronological age is a slightly better index of tooth development than is skeletal age. They further noted that skeletal and dental age may vary independently. In 1959 Lamons and Gray in a second paper stated that there is little question that new standard tables for development of the dentition are needed.

In 1959 Hotz published a paper on the relation of dental calcification to chronological and skeletal age. His material consisted of records from 148 boys and 150 girls between the ages of 6 and 11 years, plus or minus one month. The six age-groups each containing twenty to twenty-eight children. Hotz reported that, ' it seems that a very close association exists between dental, chronological, and skeletal age '.

In 1961 Lauterstein reported the findings of a cross-sectional study into dental development and skeletal age. He examined 132 ' six-year-old ' children, children between the ages of 16 and 82 months. He found that an intimate correlation exists between ' root age and bone age '.

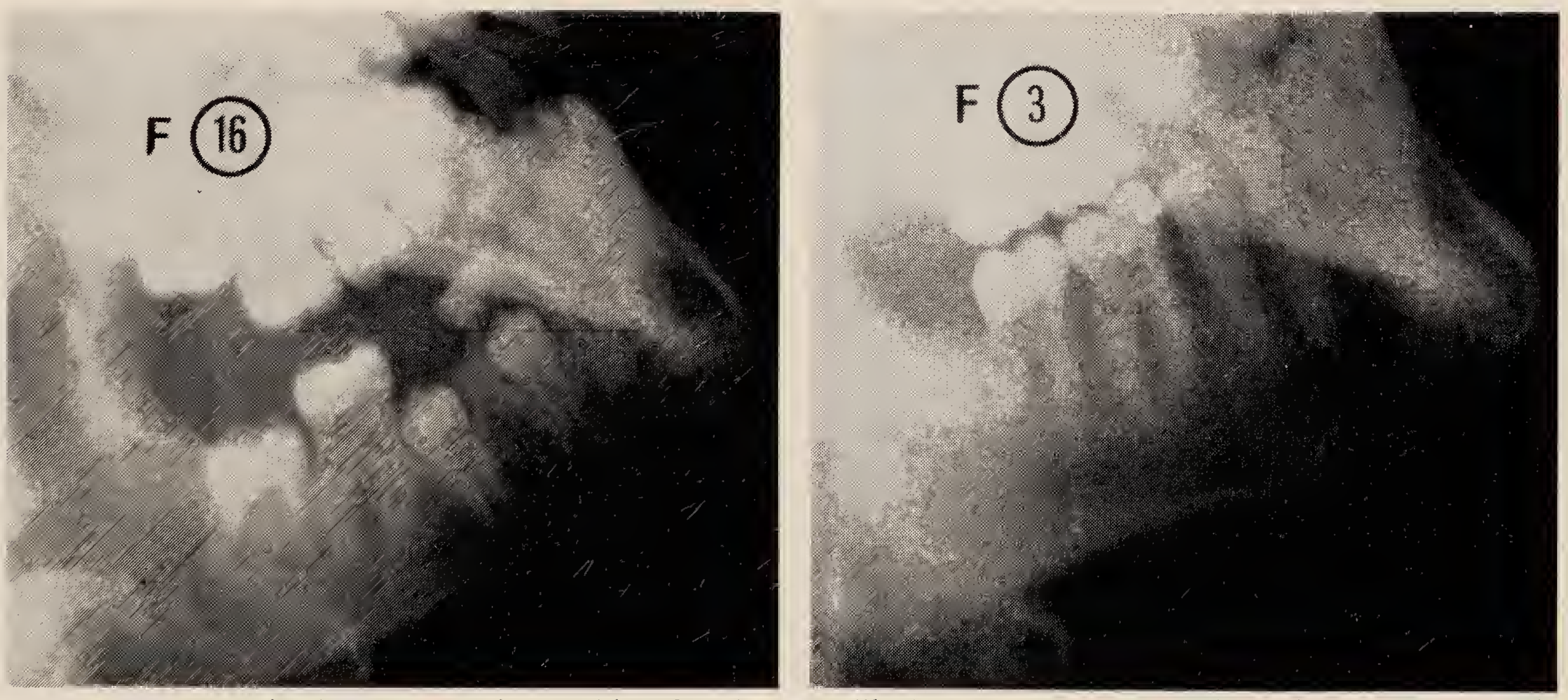
A B

Fig. 1.—Extremes in dental maturity ranking for the mandibular second premolar. Girls. A, Least mature in the rank (*Case* F.6); B, Most mature in the rank (*Case* F.18).



A B

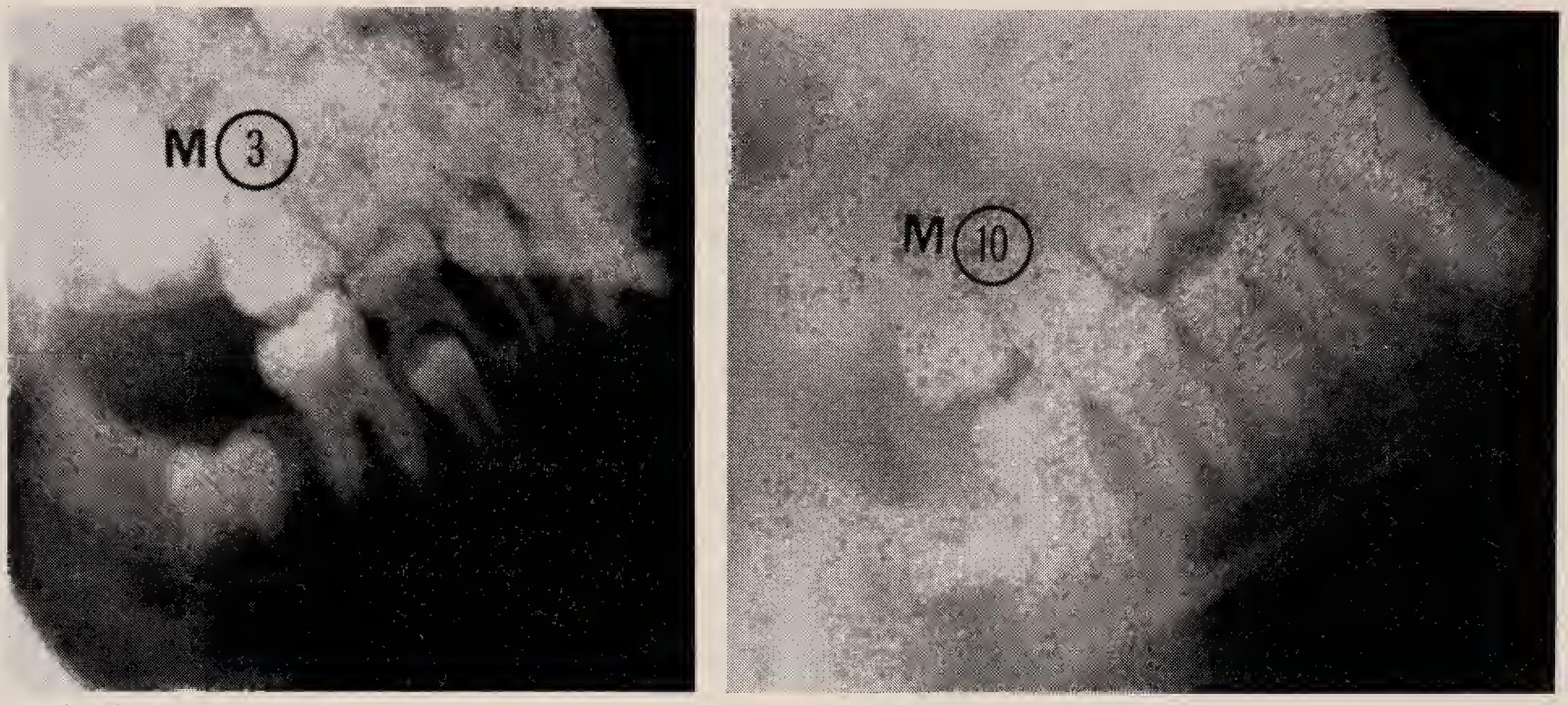
Fig. 2.—Extremes in dental maturity ranking for the mandibular second premolar. Boys. A, Least mature in the rank (*Case* M.8); B, Most mature in the rank (*Case* M.11).



A B

Fig. 3.—Extremes in dental maturity ranking for the mandibular second molar. Girls. A, Least mature in the rank (*Case* F.16); B, Most mature in the rank (Case F.3).

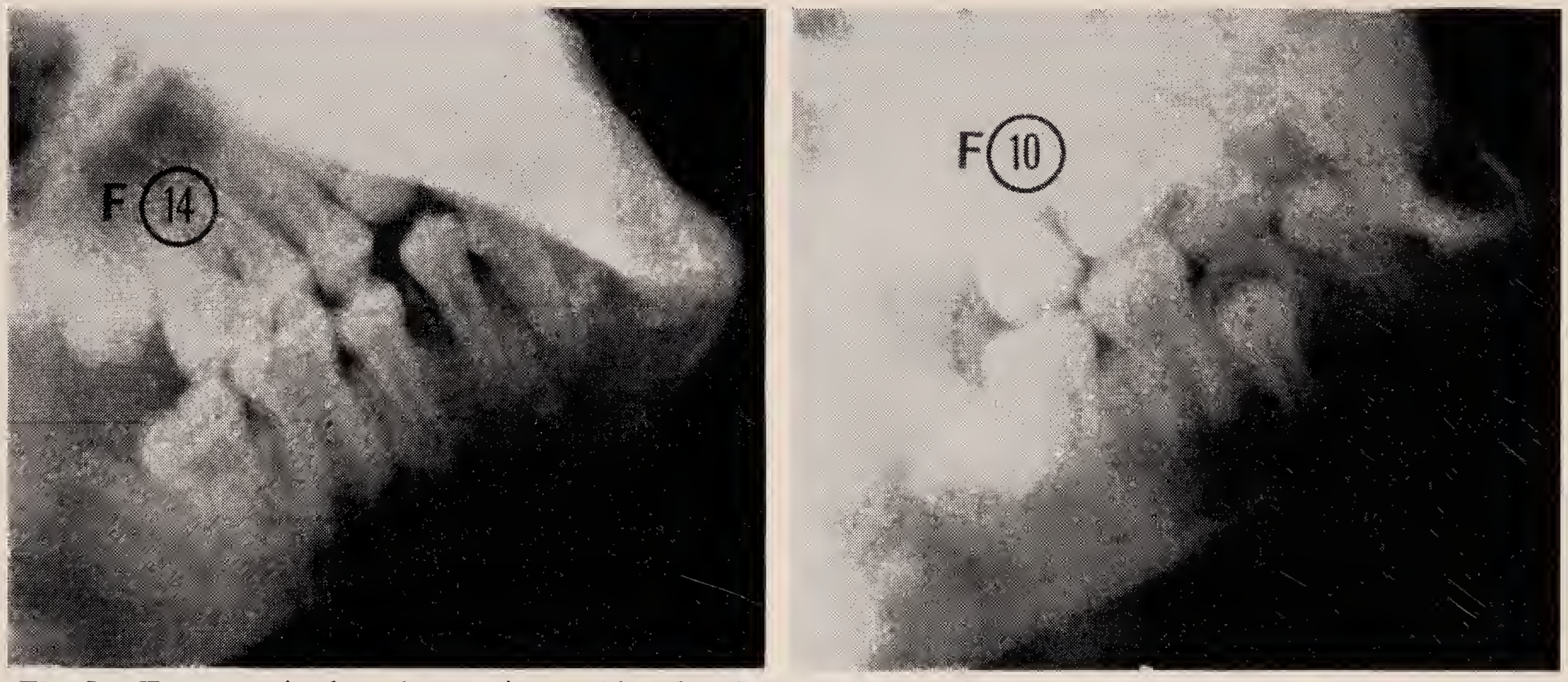
A



B

Fig. 4.—Extremes in dental maturity ranking for the mandibular second molar. Boys. A, Least mature in the rank (*Case* M.3); B, Most mature in the rank (*Case* M.10).

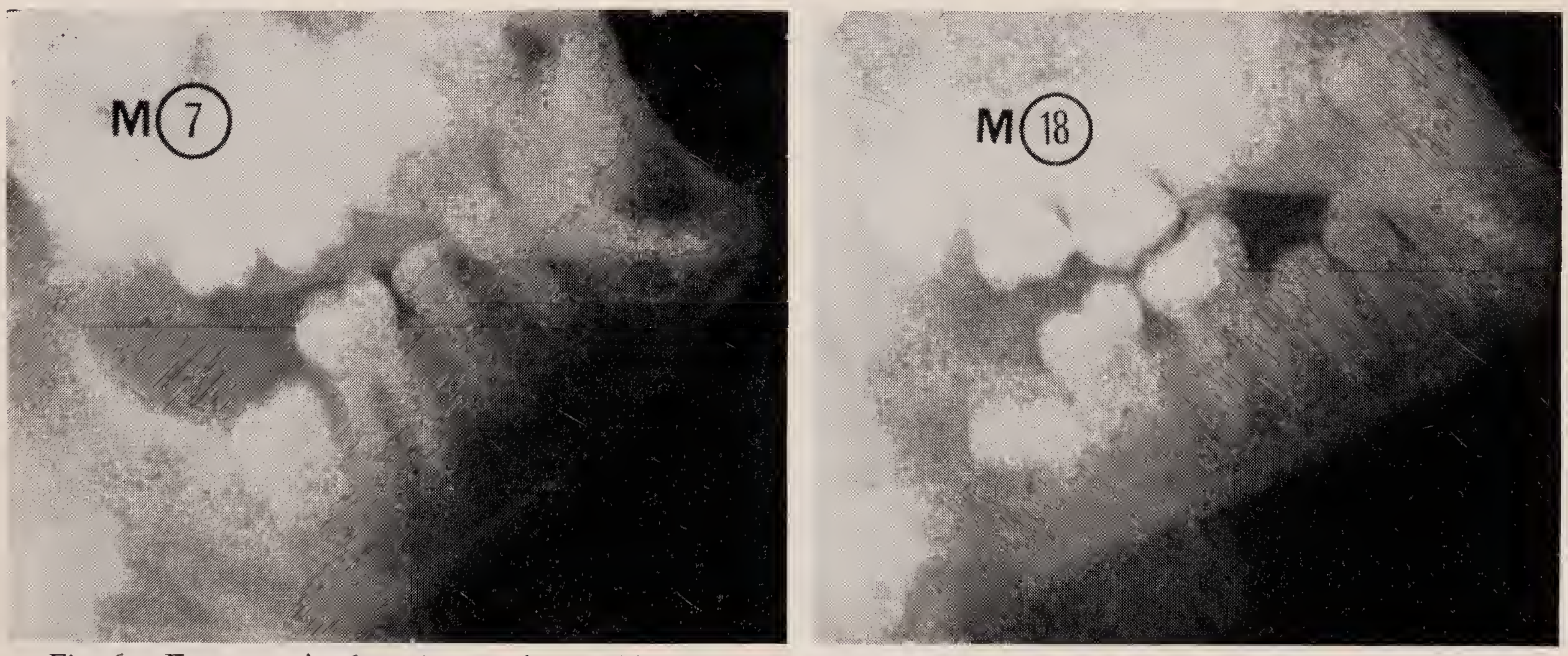
A



B

Fig. 5.—Extremes in dental maturity ranking for the mandibular third molar. Girls. A, Least mature in the rank (*Case* F.14); B, Most mature in the rank (*Case* F.10).

A



B

Fig. 6.—Extremes in dental maturity ranking for the mandibular third molar. Boys. A, Least mature in the rank (*Case* M.7); B, most mature in the rank (*Case* M.18).

On review of this literature several authorities (Spier, 1918; Wallis, 1931; Shuttleworth 1939; and Clements, Davies-Thomas, and Pickett, 1953) claim that advanced dental development, assessed from the eruptive state of the dentition, is associated with advanced physiological development. Others claim a similar relationship between early eruption and advanced skeletal age (Wallis 1931; Sutow, Terasaki, and Owaha, 1954). Nicolson and Hanley (1953) have shown that skeletal age is a reliable measure of general physiological maturation. It would seem correct to conclude that advanced ‘eruptive’ dental development is associated with advanced general physiological development. Gleiser and Hunt (1955) claimed that calcification of a tooth may be a more reliable measure of physiological maturity than tooth eruption. If this is so, and it would appear reasonable to postulate so, then dental development assessed from the extent of root formation should be more closely related to physiological maturity than when assessed from the eruptive state of the dentition. The reports published by Lamons and Gray, Hotz, and Lauterstein investigated this relationship. Lamons and Gray found that dental age and skeletal age vary independently, whilst Hotz and Lauterstein claim a more intimate relationship. Although Lamons and Gray are in the minority their work cannot be dismissed in view of the findings of Hotz and Lauterstein. However, the findings of the latter are in agreement with the results which must be anticipated from the relationship between tooth eruption and physiological maturity. The findings of Lamons and Gray being at difference with the concept which has been claimed by many, but not convincingly proved to date, deserve recognition but call for further research.

Table I.—Maturity Ranking

Girls	1. L.A.	2. D.R.	3. L.C.	4. C.M.	5. E.F.	6. K.S.	7. L.W.	8. M.M.	9. C.D.	10. C.T.	11. L.R.	12. L.C.	13. S.G.	14. S.A.	15. G.G.	16. S.M.	17. S.F.	18. Y.M.	19. I.D.	20. P.B.	21. S.C.
Dental Maturity Ranking —second premolar	7	2	11	4	18	1	20	14	6	9	17	15	8	5	10	3	13	21	12	16	19
Dental Maturity Ranking —second molar	8	15	21	5	10	4	20	16	12	13	19	3	2	7	17	1	14	18	6	11	9
Dental Maturity Ranking —third molar	3	11	5	*	17	4	13	9	16	19	14	18	7	1	12	*	6	15	2	8	10
Dental Maturity Ranking —average	6	8	13	4	18	2	20	15½	10	17	19	12	5	3	15½	1	9	21	7	11	14
Skeletal Maturity Ranking	6	12	21	10	20	3	5	9	18	14	2	8	4	16	19	1	17	13	11	7	15

Boys	1. G.E.	2. R.E.	3. A.J.	4. A.D.	5. M.B.	6. D.R.	7. J.S.	8. T.W.	9. J.R.	10. W.M.	11. S.S.	12. M.Y.	13. D.T.	14. S.N.	15. K.E.	16. I.D.	17. D.H.	18. J.H.	19. J.E.	20. D.B.	21. H.J.
Dental Maturity Ranking —second premolar	2	3	15	9	5	14	12	1	8	19	20	*	4	7	17	18	11	6	13	10	16
Dental Maturity Ranking —second molar	9	10	1	16	19	5	7	4	14	21	17	3	6	8	18	20	15	12	2	11	13
Dental Maturity Ranking —third molar	14	*	*	15	9	2	1	3	10	13	8	*	5	4	11	16	6	17	*	7	12
Dental Maturity Ranking —average	10	5	9	16	14	7	6	1	12½	20	18	2	3	4	19	21	12½	15	8	11	17
Skeletal Maturity Ranking	7	5	16	8	9	6	15	1	2	12	3	21	20	13	14	11	4	18	19	17	10

Least mature = 1   * = tooth absent or no evidence of formation

INVESTIGATION

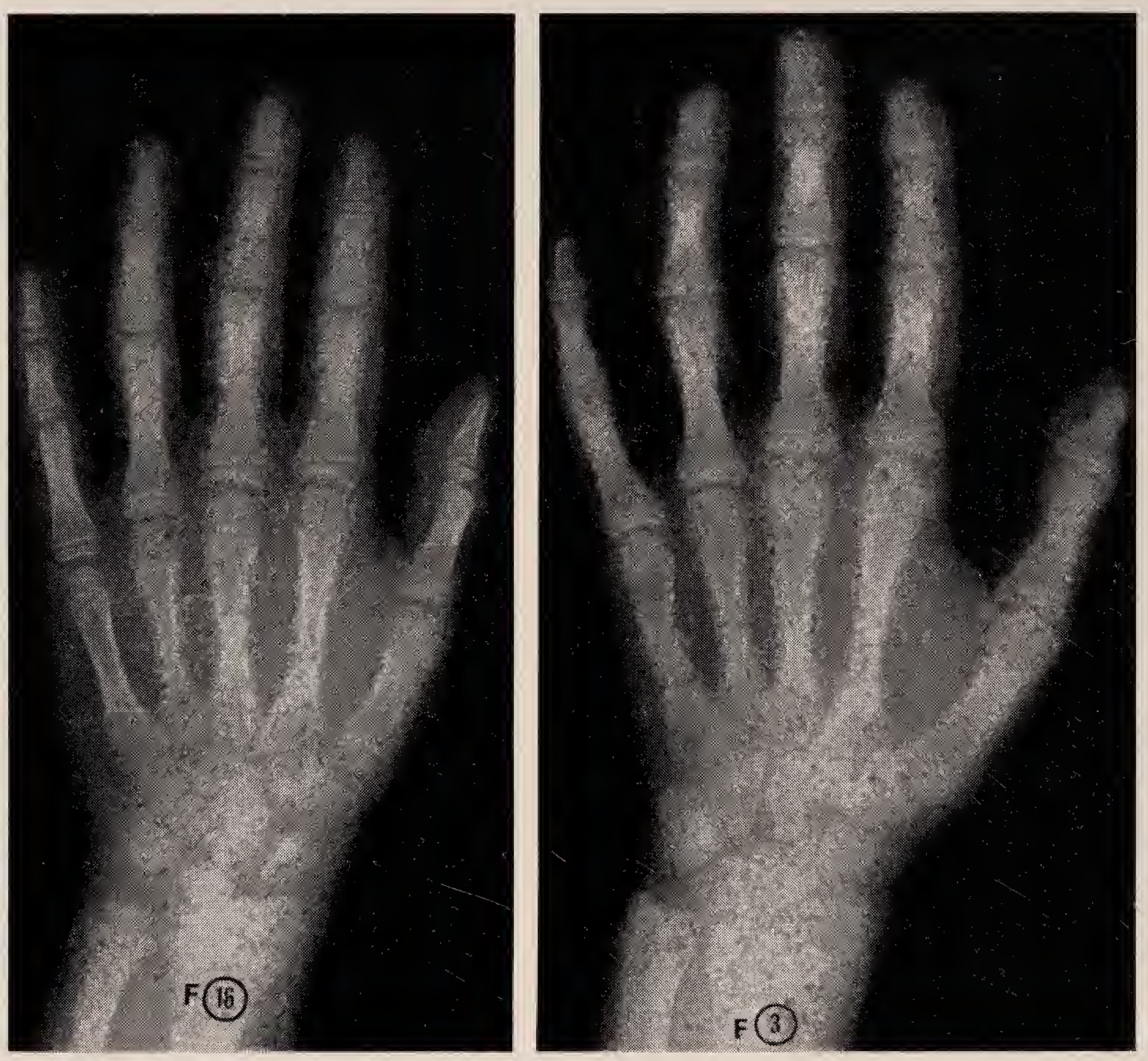
In order to investigate the direct relationship which exists between dental maturation and skeletal age it was decided to collect lateral jaw radiographs and hand-wrist radiographs from a group of 12-year-old children.

The lateral jaw radiographs show the developmental status of the mandibular second premolar and second and third molars (*Figs.* 1–6). In

order to avoid error due to age scatter all the records were obtained within one week of the child's twelfth birthday. They all attended a secondary modern school and may be regarded as being representative of a middle socio-economic range of the population. They all have a normal medical background having experienced no prolonged or significant illness. Their dentitions have not been mutilated by advanced caries

teeth. These tracings were then arranged in ascending order of development of the mandibular second premolar and the order of ranking recorded. This was then repeated for the second and third molars. If the tooth in question was found to be absent that case was left out of the rank. On completion of this ranking procedure it was noted that there was little agreement between the three individual dental rankings. A case

A



B

Fig. 7.—Extremes in skeletal maturity ranking. Girls. A, Least mature in the rank (*Case* F.16); B, Most mature in the rank (*Case* F.3).

or multiple extractions. They have not received orthodontic treatment. To this extent the children were selected, and because of these requirements the availability of suitable children was limited. Eventually twenty-one girls and twenty-one boys were included in the study.

The children were allocated a reference number of one to twenty-one as their records were accepted, this order being quite by random. An odd number was selected so that when the individual records were arranged in an ascending order of maturity, record number eleven would represent the mean of the series.

The lateral jaw radiographs were each traced so as to provide a simple means of recording the state of development reached by the mandibular second premolar and second and third molar

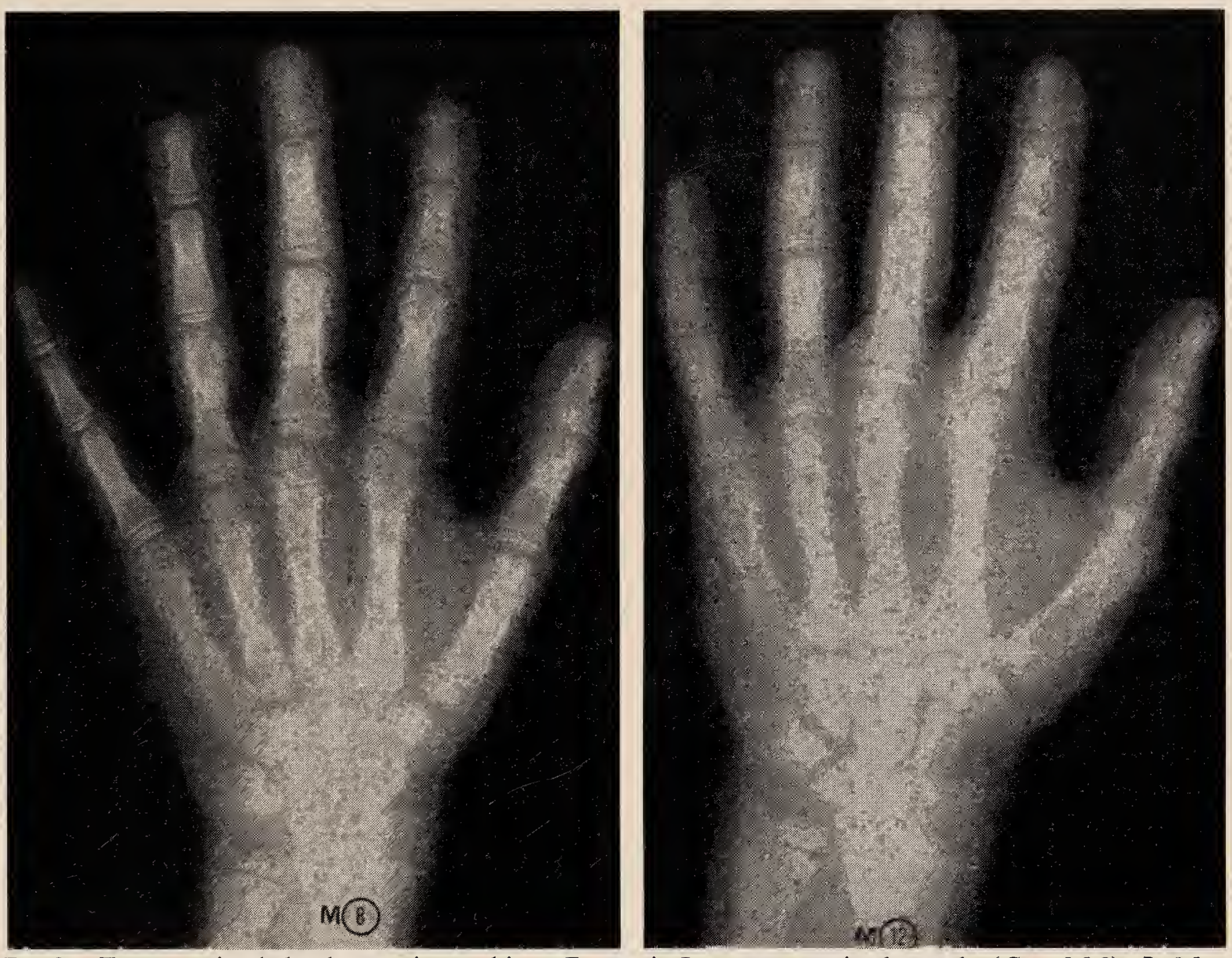
which is relatively advanced in second premolar development may be delayed in second or third molar development. It was therefore apparent that it is not possible to assess dental maturity from the development status of any one tooth. In an attempt to overcome this difficulty an average dental maturity status was estimated by taking the mean of the three dental maturity rankings and then arranging these mean values in a rank.

The wrist radiographs were arranged in order of progressive maturity and the ranking order recorded (*Figs.* 7, 8). No attempt was made to give a particular skeletal age, by comparison to standards, as it was obvious that many of the radiographs were very close to each other in maturity. However, by comparison to one

another it was possible to place the individual records in an order of progressive maturity. Only the mean and the extremes, that is records

In order to test the significance of the correlation coefficients the Student's t was calculated. The correlation coefficients are given in *Table II.*

A



B

Fig. 8.—Extremes in skeletal maturity ranking. Boys. A, Least mature in the rank. (*Case* M.8); B, Most mature in the rank (*Case* M.12).

one, eleven, and twenty-one in the skeletal maturity ranking, were compared to standards and designated a skeletal age.

ANALYSIS AND FINDINGS

The individual dental maturity rankings for the mandibular second premolar, second and third molars, the average of these, and the skeletal maturity ranking are shown in *Table I.*

Each of the dental maturity rankings were in turn compared to the skeletal maturity ranking and Spearman's Correlation Coefficient calculated according to the formula:—

Spearman's Rank Correlation Coefficient

$$= R = 1 - \frac{6 \times d^2}{n^3 - n}$$

In the case of ties in the ranking, as occurred in the average dental maturity ranking, the following correction was applied:—

For every tie of two subtract 6 from $n^3 - n$.

On comparison of the individual dental maturity rankings and the skeletal ranking it was noted that certain cases which were relatively advanced dentally were retarded skeletally. Other cases were noted to be relatively retarded dentally and advanced skeletally. This intervariation between dental and skeletal maturity is illustrated in *Figs.* 9 and 10.

DISCUSSION

One of the most fascinating aspects of the general development of children is the great individual variation which occurs. Children of the same chronological age are not necessarily all of the same developmental age. The question arises, ' If a child is advanced in one aspect of maturity, is he equally advanced in another? ' For instance, if a child is advanced in dental development, is he equally advanced in skeletal development? In the present investigation an

attempt has been made to estimate the degree of dental and skeletal maturity attained by a group of 12-year-old children and then to compare and contrast these estimates. than if the records had been collected within one month of the child's birthday. When the individual records were arranged in order of progressive maturity it was immediately apparent

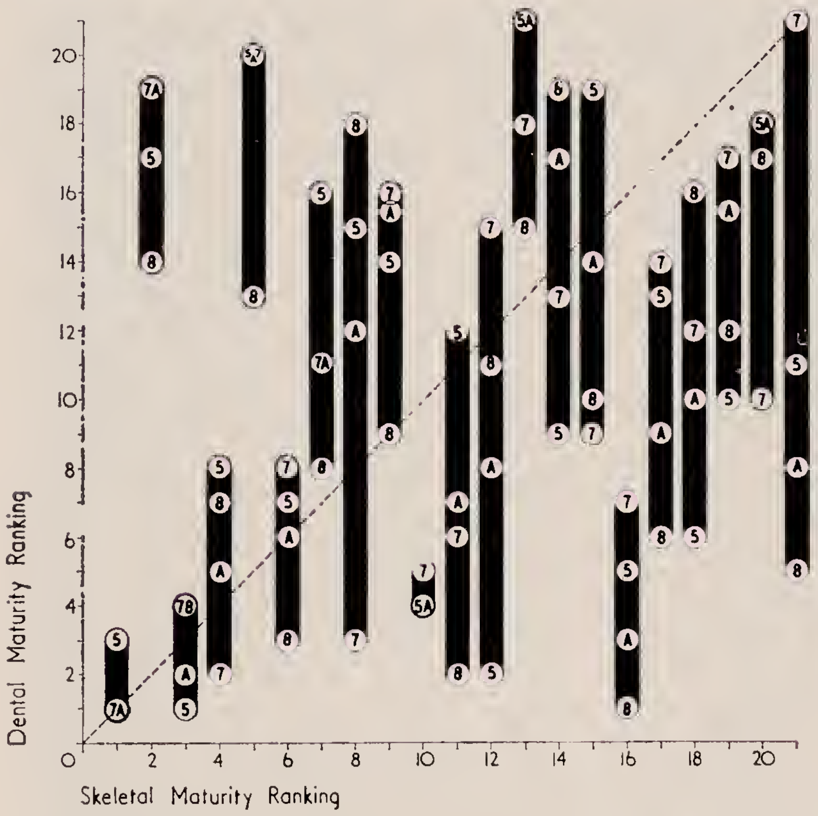


Fig. 9.—Intervariation between the dental maturity rankings and the skeletal maturity ranking. Girls. 5 = Dental maturity ranking: second mandibular premolar. 7 = Dental maturity ranking: second mandibular molar. 8 = Dental maturity ranking: third mandibular molar. A = Dental maturity ranking: average.

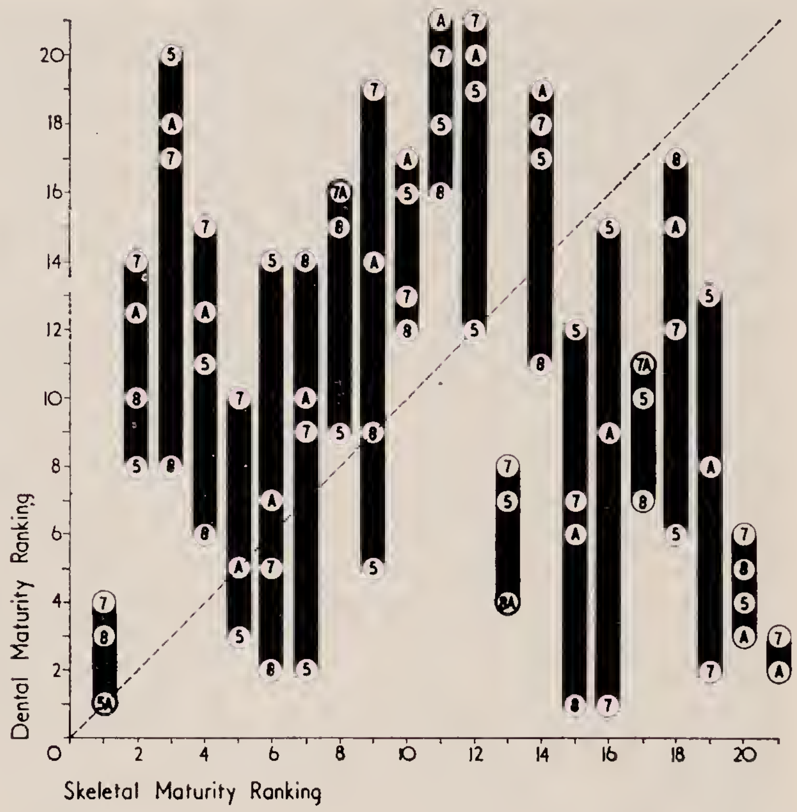


Fig. 10.—Intervariation between the dental maturity rankings and the skeletal maturity ranking. Boys. 5 = Dental maturity ranking: second mandibular premolar. 7 = Dental maturity ranking: second mandibular molar. 8 = Dental maturity ranking: third mandibular molar. A = Dental maturity ranking: average.

Table II.—SPEARMAN'S RANK CORRELATION COEFFICIENTS
(Dental maturity ranking: skeletal maturity ranking)

DENTAL MATURITY RANKING	GIRLS				BOYS			
	Spearman's Rank Correlation Coefficient	*Student's t*	*No. in sample*	*5 per cent level of probability*	*Spearman's Rank Correlation Coefficient*	*Student's t*	*No. in sample*	*5 per cent level of probability*
Second premolar	0·132	0·58	21	2·09	0·130	0·56	20	2·10
Second molar	0·374	1·83	21	2·09	—0·328	1·51	21	2·09
Third molar	0·011	0·04	19	2·11	—0·045	0·17	17	2·13
Average	0·279	1·27	21	2·09	—0·151	0·67	21	2·09

The Student's *t* in each case being less than the 5 per cent probability level the coefficients are shown to be not significant.

The jaw and wrist radiographs, used in assessing the dental and skeletal maturity, were collected within one week of the child's birthday. This reduced the extent of the possible error due to age-scatter to a minimum. The range in developmental status within the group being less that there was a distinct range in maturity present in each rank. The first and twenty-first records in each rank represented relatively immature and mature stages of development. These extremes for each rank are included in the illustrations. The extremes for the skeletal maturity

ranks, when compared to the Greulich-Pyle standards, represented an age range of 8 years 10 months to 13 years for the girls and 10 years to 13 years 3 months for the boys (*Table III*). The eleventh or middle case in the order of ranking may be regarded as a mean for the rank. When these cases were compared with the Greulich-Pyle standards they represented a mean skeletal age of 12 years for the girls and 11 years for the boys. These cases do not represent a true statistical mean for the rank as the method does

Table III.—Range in Skeletal Ages

Skeletal Ranking		Case	Greulich-Pyle		
			Skeletal Age		Standard
			yr.	*mth.*	
Girls	1	F.16	8	10	17
	11	F.19	12	0	20
	21	F. 3	13	0	21
Boys	1	M. 8	10	0	19
	11	M.16	11	0	20
	21	M.12	13	3	22

not allow for the presence of an excess of relatively immature or mature cases. However, this method has in the past been used in the establishment of skeletal age standards. In these assessments of skeletal age it is appreciated that the American child may be slightly in advance of the English child. The existence of these ranges in the sample demonstrates that such ranges could be found in any other group regardless of size. In a larger group the ranges could possibly be shown to be greater, but not smaller.

On comparison of the individual rankings it is noticeable that there is little agreement between the three primary dental rankings. A case which is relatively advanced in second premolar formation may be delayed in second or third molar formation. This variation in tooth development has been noted by Lamons and Gray (1959) and it would appear to be a normal feature of dental development. During analysis of the material this variation in maturity status between the individual teeth was noted, and in an attempt to overcome it an average dental maturity status score was calculated. Owing to the relative smallness of the sample it is not possible to comment on the relative reliability of any one tooth.

When the dental maturity rankings and the skeletal maturity rankings were compared great variation was apparent. Individual cases were found to be relatively advanced dentally in the series, i.e., with high-ranking numbers, whilst they were relatively retarded skeletally. *Cases* F.11 and M.11 are of this type. Other cases showed the reverse, being delayed dentally and advanced skeletally, for example *Cases* F.14 and M.12. Again, other cases were found to be equally advanced or retarded in both dental and skeletal development (*Table IV*) This intervariation was referred to during analysis of the material

Table IV.—Variation in Dental and Skeletal Ranking

	Case	Average Dental Maturity Ranking	Skeletal Maturity Ranking
Advanced dentally and retarded skeletally	F.11	19	2
	M.11	18	3
Retarded dentally and advanced skeletally	F.14	3	16
	M.12	2	21
Advanced dentally and skeletally	F.5	18	20
	M.18	15	18
Retarded dentally and skeletally	F.16	1	1
	M.8	1	1

and is strikingly illustrated in *Figs*. 9 and 10. The presence of such cases illustrates how dental and skeletal maturity can vary independently. It was thus apparent, even before calculation of the correlation coefficients, that in this series of cases there was little uniformity in the dental and skeletal rankings.

Spearman's generally low-rank correlation coefficients which were obtained for each of the dental maturity rankings and the skeletal maturity rankings confirm the low correlation which exists between the maturation of these systems. When the Student's t test was applied it was found that with the number on the sample the coefficients showed the existence of no significant correlation between any of the dental rankings and the skeletal ranking. The correlation coefficients show the overall low correlation, but they do not demonstrate the existence of the individual cases in which the extreme variation between dental and skeletal maturity occurred. The great variation in the coefficients obtained for the individual maturity rankings relative to the skeletal maturity ranking may be due to the smallness of the sample.

In view of the range of maturity and the extreme independent relationship between dental and skeletal maturity which has been shown to

be present it is reasonable to make observations based on this relatively small group. However, in view of the numbers investigated it would be unwise to place too great emphasis on the value of the correlation coefficients. In the analysis of the material in the investigation, it would appear that the graphic illustration of the ranking of the dental and skeletal maturity status is significant.

analysis of a small group if such a group contained a preponderance of one type of extreme case. It is possible that the groups used by Hotz and by Lauterstein were of this nature.

In the literature there are many reports which confirm that advanced eruptive development of the dentition is related to advanced physiological development. It is difficult to correlate this

Table V.—CORRELATION COEFFICIENTS BETWEEN AGES AT WHICH VARIOUS CRITERIA OF MATURITY ARE REACHED

(Data from Nicolson and Hanley, 1953: Reproduced with permission from *Growth at Adolescence*, by J. M. Tanner published by Blackwell Scientific Publications.)

	Menarche	Breast 2	Hair 2	Peak height velocity	Skeletal 9¾	Skeletal 12¾	90 per cent height	99 per cent height
Menarche	—	·74	·74	·71	·64	·85	·86	·72
Breast stage 2	·74	—	·75	·80	·72	·82	·85	·71
Pubic hair stage 2	·74	·75	—	·75	·69	·81	·80	·71
Peak height velocity	·71	·80	·75	—	·69	·81	·84	·72
Skeletal standard 9¾	·64	·72	·69	·69	—	·78	·75	·73
Skeletal standard 12¾	·85	·82	·81	·81	·78	—	·93	·79
90 per cent mature height	·86	·85	·80	·84	·75	·93	—	·85
99 per cent mature height	·72	·71	·71	·72	·73	·79	·85	—

	Secondary sex character 2	Peak height velocity	Skeletal 11¼	Skeletal 14¾	90 per cent height	99 per cent height
Secondary sex character stage 2	—	·67	·35	·69	·73	·64
Peak height velocity	·67	—	·31	·83	·90	·82
Skeletal standard 11¼	·35	·31	—	·52	·47	·27
Skeletal standard 14¾	·69	·83	·52	—	·95	·87
90 per cent mature height	·73	·90	·47	·95	—	·93
99 per cent mature height	·64	·82	·27	·87	·93	—

Figs. 9 and 10 illustrate the great variation in dental and skeletal ranking which has occurred within the sample. The existence of such extremes of variation leaves no doubt as to the relationship which exists between dental and skeletal maturity. It can only be that dental and skeletal maturation vary independently.

The findings of this investigation are in agreement with the conclusions of Lamons and Gray (1958, 1959) that dental and skeletal maturation may vary independently. The great variation in dental and skeletal maturity status in certain of the cases denies the existence of an intimate relationship as claimed by Hotz (1959) and Lauterstein (1961). From the great variation in the individual cases it would appear possible to obtain a false impression from a purely statistical

relationship to the findings of the present investigation. It may be that the solution lies in the unreliable nature for using the eruptive state of the dentition as a measure of dental maturity. As stated previously, tooth eruption is influenced by local environmental factors and is beyond direct control of the individual's inherent growth potential.

Nicolson and Hanley (1953) investigated the relationship which exists between various measures of physiological maturity in a longitudinal study. For girls they obtained correlation coefficients for the age at which:—

1. Menarche occurs.
2. The breasts reach stages 2, 3, and 4.
3. The pubic hair reaches stages 2, 3, and 4.
4. Peak height velocity occurs.

5. Todd skeletal standards $9\frac{3}{4}$, $12\frac{3}{4}$, and $16\frac{1}{4}$ are reached.

6. Eighty per cent, 90 per cent, and 99 per cent of mature stature is attained.

For the boys equivalent data were used. The coefficients are given in *Table V.* All the coefficients are high for the girls whilst those for the boys are lower. These coefficients show the intimate relationship which exists between the various criteria of maturity, although the relationship is not so intimate in boys. It is interesting to observe this fact as this tendency is also present in the correlation coefficients obtained in the present investigation, shown in *Table II.* Nicolson and Hanley show the value of age at menarche and the secondary sex ratings in assessing physiological maturity. However, the age at reaching the Todd skeletal standard of $12\frac{3}{4}$ years for girls and $14\frac{3}{4}$ years for boys is equally reliable. Applying this to the present investigation it would seem that skeletal age is a reliable method of estimating general maturation but for the age-group, i.e., 12-year-olds, it is more reliable for the girls than the boys. This may in part explain the lower correlation coefficients which were obtained for the boys.

In this investigation skeletal maturation has been used as a measure of general somatic maturation. In returning to the original objective it may be stated that there exists a low correlation between dental maturation and general somatic maturation. It has been shown that dental maturation can vary independently of general somatic maturation.

Maturation is a continuous process, but does not necessarily progress at a constant rate. This concept is expressed by Lamons and Gray as follows: ' progress towards maturity is more like the progress of an informal group of friends on a walk than like the progress of a company of soldiers in strict formation moving at a constant rate of speed. Now one pair walks together; now they divide to walk with others. Some run ahead, others lag behind and even stop to rest; yet all reach the same goal in the normal course of events '. This concept of erratic but continuous maturation occurring in uncoordinated waves within the various systems, i.e., dental and skeletal, is in agreement with the findings of the present investigation. It is compatible with the report by Brodie (1944) of temporary disharmonies (crowding) due to slow or fast rate of growth in the bone compared to eruption of the teeth. Further research of a longitudinal nature is required, and it would be an advantage to include criteria of a general physiological maturity other than skeletal age.

CONCLUSIONS

1. The existence of a wide range in dental maturity status in 12-year-old girls and boys has been demonstrated.

2. The existence of a similar range in skeletal maturity has been confirmed.

3. It has been shown that the mandibular second premolar and second and third molars vary independently in their maturity status.

4. It has been demonstrated that in 12-year-old children there is no direct interdependence between dental and skeletal maturation.

5. Accepting skeletal maturation as being a reliable measure of general somatic maturity, it has been shown that there exists a low correlation between dental maturation and general somatic maturation.

Acknowledgements

I wish to express my appreciation of the assistance and guidance of Professor G. E. M. Hallett in the pursuance of this investigation. For introducing me to this subject I am ever grateful to Professor C. F. Ballard, and, subsequently, to Dr. J. M. Tanner for stimulating and sustaining my interest in growth and development.

I acknowledge the facilities afforded me by the Council of the City and County of Newcastle upon Tyne which enabled me to recruit the children included in this study. I appreciate the assistance of Dr. R. C. M. Pearson, Medical Officer of Health and Principal School Medical Officer, and Dr. H. S. K. Sainsbury, Senior School Medical Officer in arranging these facilities. I appreciate the co-operation, patience, and tolerance of the head-teachers, parents, and children.

The clinical records used in this investigation were collected at the Newcastle upon Tyne Dental Hospital. I am grateful to the Board of Governors, and to the Director, Professor R. W. Lovel, for the use of clinical facilities. I am indebted to Dr. D. J. Newell for advice and guidance in the statistical analysis of the material.

REFERENCES

BLACK, G. V. (1908), *Trans. Ill. dent. Soc.*, 1893.
BRODIE, A. G. (1944), *Amer. J. Orthodont.*, **30,** 444.
CATTELL, P. (1928a), *Dentition as a Measure of Maturity*, Harvard Monogr. Educ. No. 9. Cambridge, Mass.: Harvard University Press.
— — (1928b), *J. dent. Res.*, April, 279.
CLEMENTS, E. B. M., DAVIES-THOMAS, E., and PICKETT, K. G. (1953), *Brit. med. J.*, **1,** 1425.
GLEISER, E. E., and HUNT, J. (1955), *Amer. J. Phys. Anthrop.*, **38,** 479.
HOTZ, R. (1959), *Trans. europ. orthod. Soc.*, 140.
KROGMAN, W. M. (1955), *J. dent. Med.*, **10.**
LAMONS, F. F., and GRAY, S. W. (1958), *Amer. J. Orthodont.*, **44,** 687.
— — — — (1959), *Ibid.*, **45,** 272.
LAUTERSTEIN, A. M. (1961), *J. Amer. dent. Ass.*, **62,** 35.
LEGROS, C., and MAGITOT, E. (1880), in *Dental Histology and Embryology*, 4th ed., ed. NOYES, F. B. Philadelphia: Lea & Febiger.
LOGAN, W. H. G., and KRONFELD, R. (1935), *J. Amer. dent. Ass.*, **20,** 379.

Nicolson, A. B., and Hanley, G. (1953), *Child Develop.*, **24**, 3.
Pierce, G. N. (1884), *Dent. Cosmos.*, **26**, 449.
Sarnas, K. V. (1956), *Trans. europ. orthod. Soc.*, 156.
Shuttleworth, F. K. (1939), *Monogr. Soc. Res. Child Develop.*, **4**, No. 3.
Spier, L. (1918), *Amer. Anthrop.*, **20**, 37.
Sutow, W. W., Terasaki, T., and Owaha, K. (1954), *Pediatrics*, **14**, 327.
Tanner, J. M. (1955), *Growth at Adolescence.* Oxford: Blackwell.
Todd, T. W. (1932), *Int. J. Orthod.*, **18**, 799.
Wallis, R. S. (1931), *Univ. Ia Stud. Child Welf.*, **5**, 737.

DISCUSSION

Mr. P. H. Burke, opening the discussion, said that his first critical comment was that Mr. Steel's groups, as he had himself mentioned, were too small. Those who had rubbed their noses up against the difficulties of studies in growth knew only too well how difficult it was to produce records of adequate quality for groups of boys and girls of large enough size. He hoped, therefore, that Mr. Steel was continuing to collect information from these children so that their approach towards maturity in the dental and skeletal fields could be examined in the light of another dimension.

One could not examine the validity of work on growth without understanding a little about the use and limitations of statistics. The wisest way to do this was to consult the medical statistician at the stage when the study was being planned. Judging from the excellent way in which Mr. Steel had presented his findings, he would hazard a guess that this work had been planned from the beginning in this way.

Turning to Mr. Steel's methods of assessing dental and skeletal age, Mr. Steel mentioned the great variation in the maturity rating of the three teeth which he used for assessing dental age. Of these three teeth, two were the last teeth of their particular series, and it was well known that the last tooth of a series, be it incisor, premolar, or molar, was subject to more variation than any other tooth in that series. Was this not an argument for using only the second molar for assessing dental age? In the same way, one could get variation in the development of the different bones of the hand and wrist, and Greulich and Pyle in their book had discussed the difficulty and had added: ' The hand film should therefore be supplemented by significant physical measurements and other pertinent data in any intensive study of individual children '. He asked Mr. Steel if he had recorded standing height and weight as an absolute minimum in physical measurements.

It was of interest to know that new standards of assessing skeletal age had been evolved by Tanner and Whitehouse. Their method also used carpal radiographs, but they gave the individual rating of each bone, totalled the score for each radiograph, and read the skeletal age from tables. It might be valuable for Mr. Steel to compare his rankings of skeletal age with this new method.

This work suggested that skeletal development and dental development proceeded independently, and this in turn suggested that the controlling mechanisms were independent. The little that was known about the control of growth suggested that this was under the control of genes or, more probably, gene complexes. It would therefore be of interest if Mr. Steel could enlarge his groups by the addition of diagnosed monozygotic and dizygotic twins.

What clinical application had this work? He thought that these findings, in conjunction with those recently presented to the Society by Brodie, in which he postulated that the dental base might grow a little more than had previously been thought, gave rise to the need for caution in treating these malocclusions where one had borderline crowding.

Mr. C. D. Parker asked if Mr. Steel had tried to grade the physiological maturity of his patients from their physical appearance; if so how did the results compare with their grading using wrist radiographs? In other words, how accurate is a clinical assessment of physiological maturity.

Mr. W. A. Nicol felt that eruption of the teeth was something that we, as clinicians, should look for; we did not look for the finally formed and completed root. He asked for Mr. Steel's comments.

Mr. E. K. Breakspear said he had noticed quite often that there was a difference in the degree of maturity of the third molar in the same patient between the left side and the right side. He asked if Mr. Steel had taken account of that at all in his study.

Mr. D. H. Oliver asked if it followed that a case of dental maturity plus skeletal immaturity would result in the need for orthodontic treatment? On the other hand, would dental immaturity plus skeletal maturity result in no need for orthodontic treatment?

Mr. Steel, in reply to Mr. Burke, agreed that the groups were rather small although, statistically, his findings were justified. The second molar was slightly more reliable than the second premolar or third molar although the relation was still haphazard. Although he was familiar with the Tanner-Whitehouse standards of bone age, he decided to avoid a comparison with standards as far as possible. At the time of the investigation, the Greulich and Pyle standards were available. He agreed that a study of twins would make an interesting piece of research.

In reply to Mr. Parker, he did collect facial photographs and height and weight records although these would form another study and it would be difficult to arrange the photographs in an order of progressive maturity. He agreed with Mr. Nicol that eruption was important clinically, although radiographs of unerupted teeth were often available. Eruption was just simply too unreliable to use as a measure of maturity. He noticed that sometimes the teeth on the left and right sides showed differences in their developmental state; a variation which is known to occur between left and right wrist radiographs. This was why he limited his examination to the left mandibular teeth. He agreed with Mr. Oliver that this was the type of clinical problem in which they were interested and which might form a future application of his research. The standards to estimate dental maturity must come first.

THE WATKIN FREE-SLIDING ARCH

AN INTRODUCTION

E. J. S. CLIFFORD, L.D.S., V.U. (Manch.), D.Orth. R.C.S. (Eng.)

INTRODUCTION

Angle (1916), McCoy (1927), and more recently Watkin (1933) have long been associated with the pin-and-tube appliance. Angle's design was a fairly rigid arch with which strong forces could be exerted on the dental and supporting tissues. It is not surprising, therefore, that in some hands an appliance labelled pin-and-tube inherited a reputation for root resorption and loss of vitality to incisor teeth.

The introduction of fine hard-drawn stainless-steel round wire and spot-welding techniques in the 1930's led to the introduction of new ribbon-arch designs and enabled small coils to be made in the arch wires which, being now more resilient, exerted forces which were physiologically more acceptable.

One such design was introduced by Watkin (1933). His arches incorporated loops which, replacing the soldered pins of Angle's appliance, were designed to fit into vertical box-tubes. Each loop is locked by the depression of tongues cut into the tubes (Watkin, Watkin, Clifford, and Murray, 1958). Jackson (1904) at the turn of the century used loops in tube attachments, but his appliances lacked resilience due to the unsatisfactory properties of the wire then available.

The angulation of the loop in relation to the tube provides three-dimensional control in a similar way to the edgeways arch and bracket but, due to the increased resilience of the arch, much lighter forces are available.

Watkin developed two types of appliance using these attachments, which we now prefer to call loop-and-tube and free-sliding arches respectively.

LOOP-AND-TUBE

The simple local loop-and-tube appliance is well known in the form of an arch, composed of one or more units of loops and interposed expansion and/or contraction coils constructed in 0·35 mm. hard stainless-steel wire.

They are extremely effective for the reciprocal movement of crowns and/or root apices along the line of the arch and also for reciprocal rotations.

FREE-SLIDING ARCH

This second type of appliance (*Fig.* 1) was designed in an endeavour to obtain more precise control of the incisors in non-reciprocal tooth movements. Watkin (1933) dispersed the anchorage to the buccal segments by extending a standard loop-and-tube arch wire bilaterally to

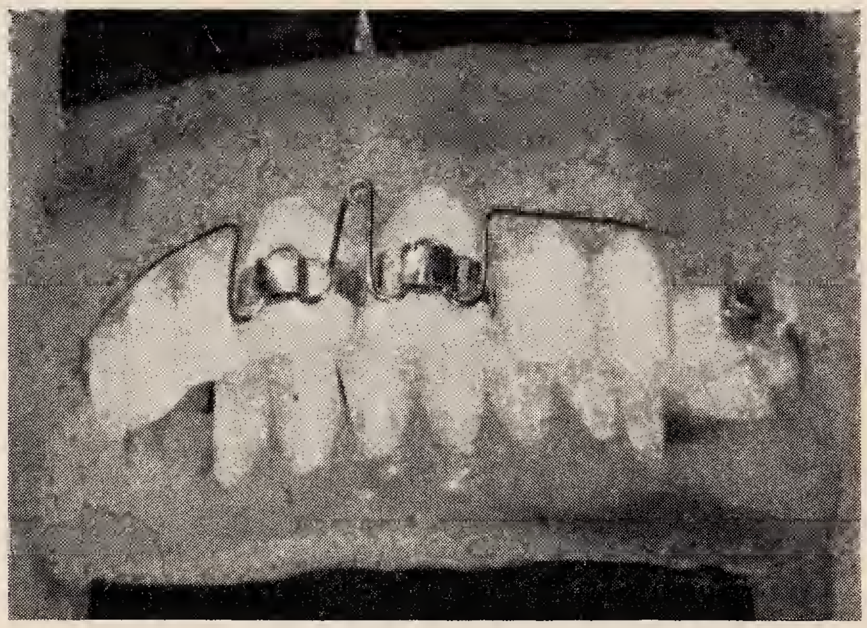


Fig. 1.—The Watkin free-sliding arch.

fit freely into horizontal buccal tubes welded to molar or premolar bands.

Leighton's (1963) recent modification of the Watkin loop-and-tube appliance was similarly designed to effect greater control of the incisors. But whilst he disperses the reaction distally with a very resilient 0·3 mm. arch stabilized posteriorly by sheathing, Watkin uses a 0·45 mm. hard stainless-steel or 0·018 in. high-tensile wire, which produces a self-supporting arch.

At this stage of development Watkin reintroduced the principle of lever-torque, advocated by McCoy (1927) and later by de Coster (1935), to obtain anteroposterior movement of the incisors simultaneously with the correction of any incisor rotations, etc. The span of arch wire extending distally from the incisors is utilized to act as a simple resilient lever.

THE LEVER-TORQUE PRINCIPLE

Fig. 2 illustrates the principle of lever-torque and shows diagrammatically a free-sliding arch

Presented at the meeting held on 8 March, 1965.

locked into the incisor box-tubes. The distal end of the buccal extension has been adjusted to lie passively below the molar attachments. The free end on insertion into the molar tubes creates torsion in the arch wire, the effect of which is to produce moments of force round an arbitrary fulcrum, on the incisor crowns and root-apices. The crowns are tipped lingually and the root-apices theoretically move in a labial direction.

The arch moves distally with lingual incisor crown movement and therefore must be free to slide through the posterior tubes. Clinically the important feature of using this simple mechanical principle to retract incisors is the absence of any reaction drawing the buccal segments forwards.

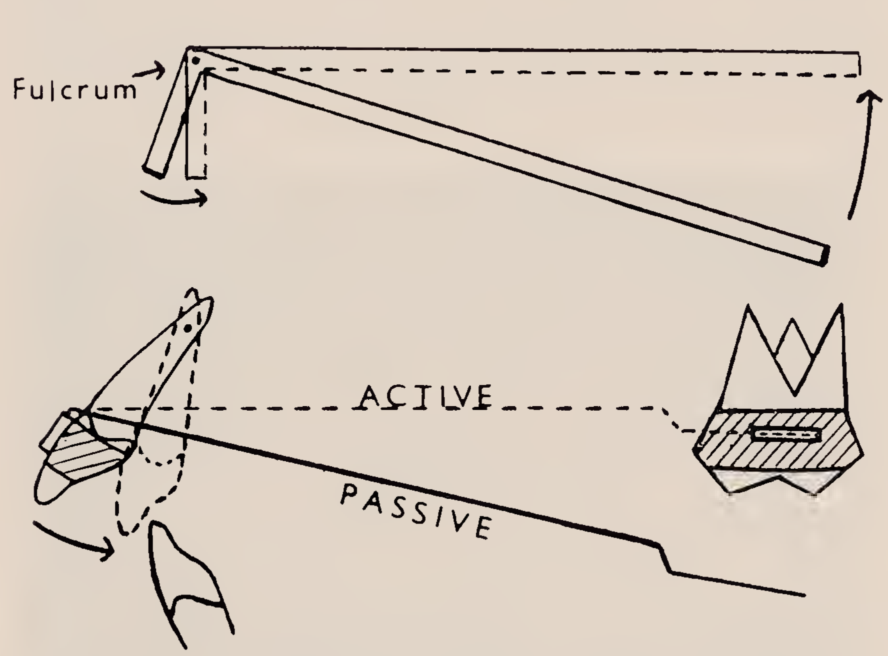


Fig. 2.—Torsion produced when passively adjusted arch is activated by insertion of free-end into molar tube. Analogy with solid beam lever hinged at fulcrum (upper diagram).

CLINICAL APPLICATIONS OF THE FREE-SLIDING ARCH

Class II, Division 1 Incisor Relationship

Although in theory it should be possible to retract all four incisors together, in practice we retract the central incisors first, followed by the laterals.

Fig. 3 is a diagram of the forces created when a 61|16 arch is activated to retract 1|1.

C is the moment of force retracting the crown and B the moment of force tending to produce apical movement. It is fundamentally important that the fulcrum f is maintained as near the root apex as possible, reducing moment of force B and thus adverse apical movement to a minimum. The position of the fulcrum varies with the magnitude of torsion and also the point of its application on the incisor crown. By placing the incisor bands high up the crowns and keeping the degree of activation small, the amount of labial apical movement becomes clinically insignificant. This is perhaps helped by the natural resistance of root apices to movement. Over-activation of an arch, however, can produce clinical signs of root movement in the labial sulcus, especially if used in Class II cases on Skeletal II bases exhibiting very unfavourable soft-tissue morphology and behaviour.

Forces A and D are small (6–7 grams) providing the arch again is not overactivated. Any depression of the incisors which might occur is temporary and obviously beneficial during the treatment of Class II cases exhibiting an excessive incisor overbite.

The importance of not overactivating a free-sliding arch has been stressed. The adjustment

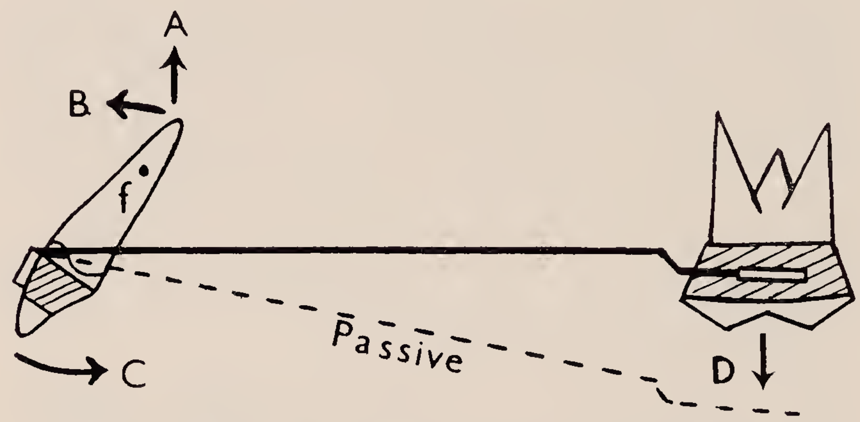


Fig. 3.—Forces created when a 61|16 arch is activated to retract 1|1. Thick line shows arch in active position.

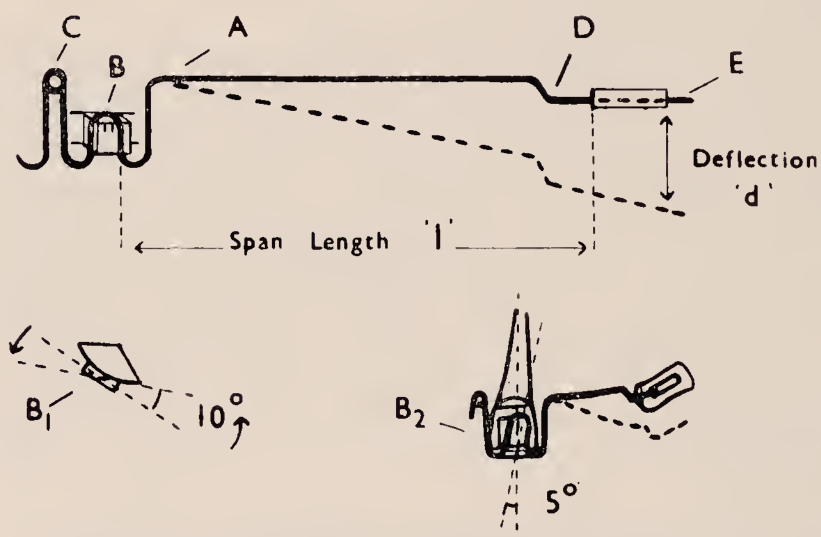


Fig. 4.—Adjustment diagram for lever-torque (61|16 free-sliding arch, left side). Incisor rotations (B_1) and neutralization of lateral splaying of incisors (B_2).

necessary to produce a physiologically acceptable torsion will now be described.

The magnitude of torsion is directly proportional to: (*a*) the modulus of elasticity (or rigidity) and the diameter of the wire, or (*b*) for practical purposes, the amount of deflexion given to the arch between its active and passive position (*Fig.* 4, d) and inversely proportional to (*c*) the length of wire between its exit from the incisor tubes to the point of entry into the posterior tubes. This length is called the arch span or span length and in practice is measured from the distal aspect of the incisor box-tube to the mesial end of the molar tube (*Fig.* 4, l).

For the retraction of two incisors using an arch of 0·45 mm. hard stainless-steel wire, correct

torsion is obtained by adjusting the arch bilaterally at A (*Fig.* 4) to produce a maximum deflexion d of 2·5 mm. for each centimetre of arch span l. This means that an arch span of 4 cm. requires a maximum deflexion of 10 mm. and a short span of 2 cm. a deflexion of 5 mm.

Where only one incisor is under active treatment the deflexion assessed for two teeth is halved.

In practice we have found it advantageous in the treatment planning stage to make the arch are the incisors. This results in a proportion of the arch torsion being expended laterally. To counteract this, each loop is angled 5° to the axes of the box-tubes as if separation of the incisor root apices was intended (*Fig.* 4, B_2).

Having completed these adjustments the arch is withdrawn from the posterior tubes, ensuring at the same time its free-sliding ability, and reinserted anteriorly so that the lever-torque deflexion, which may have been slightly altered during loop adjustment, can be checked.

Fig. 5.—First-stage treatment Class II, division 1 completed. 5| extracted. 1|1 retracted and 6| held distally with free-sliding arch 61|15.

span as long as possible by placing the posterior bands on the first or even the second molars if practical. The range of movement of the appliance being in proportion to the arch length means that a long arch requires less frequent adjustment than a short one. A 71|17 arch for example may be left for 7–8 weeks, whereas a short-spanned arch would be seen every 5–6 weeks.

Having assessed the amount of required deflexion for a given arch span and produced it by adjustment at A (*Fig.* 4), the arch is removed from the incisors and reinserted into the molar tubes. The anterior section of the arch is therefore left free and, as a check, should show the incisor loops angled approximately 10° to the vertical axes of the box-tubes. The loops may at this stage be adjusted to correct any incisor rotations by positioning the loops again with a 10° angle of activation (*Fig.* 4, B_2). Also at this stage, the loops may be positioned to produce mesiodistal crown or root movement along the arch, should closure of a diastema or the uprighting or overlapping incisor crowns be required. The expansion or contraction coil between the two loops provides the necessary resilience for these adjustments to be made. All these movements may be carried out simultaneously with incisor crown retraction.

Anteroposterior lever-torque on the incisors produces a tendency for the incisor crowns to be splayed laterally. This effect is due to the molar attachments of the arch being placed at a greater distance from the midpalatal plane than

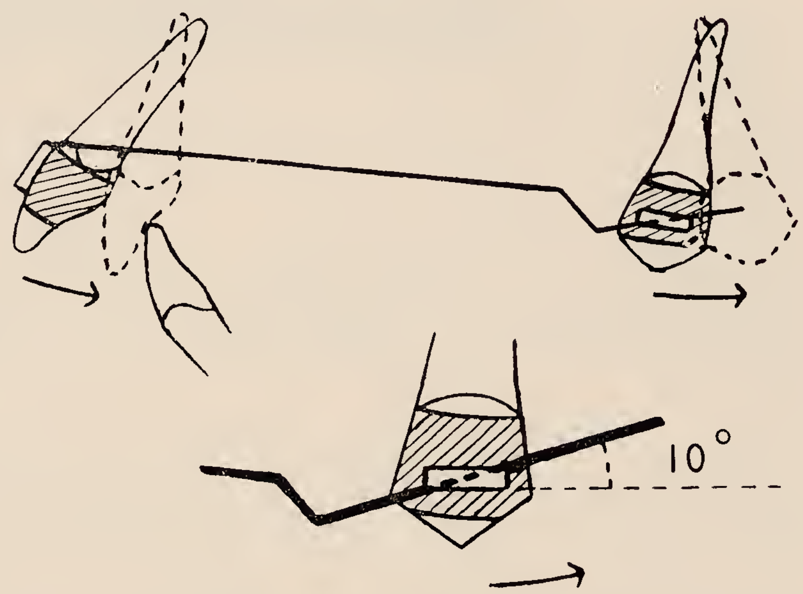


Fig. 6.—Tip-back bend adjustment to tilt premolar distally. Free-sliding arch 51|15 used to simultaneously retract 1|1 and 5|5.

Any excess wire protruding from the distal end of the posterior tubes must now be cut off to prevent trauma to the cheek mucosa (*Fig.* 4, E). As the arch moves posteriorly with the incisors this will also have to be carried out at each visit for adjustment. The amount protruding is an approximate indication of the degree of incisor retraction that has taken place.

The arch can now be reinserted into the posterior tubes and any necessary minor adjustments made to ensure that the arch is lying just free of the mucosa and the coil positioned between the loops is clear of the fraenum.

The crank (*Fig.* 4 D) allows the midsection of the arch to lie above the canines and premolars, and should be bent in such a position that it does not come into contact with the mesial end of the posterior tube before the retraction of the incisors has been completed.

Finally, the arch is locked by depressing the incisor box-tube tongues beneath the apices of the incisor loops.

It is usual in these cases for the first premolars to fall back naturally following the distal movement of the second premolars provided the occlusal interlock is weak.

The adjustment of this Class II, division 1 free-sliding arch has been described in some detail as the practical points, in the main, apply to other adaptations of the arch now to be discussed briefly.

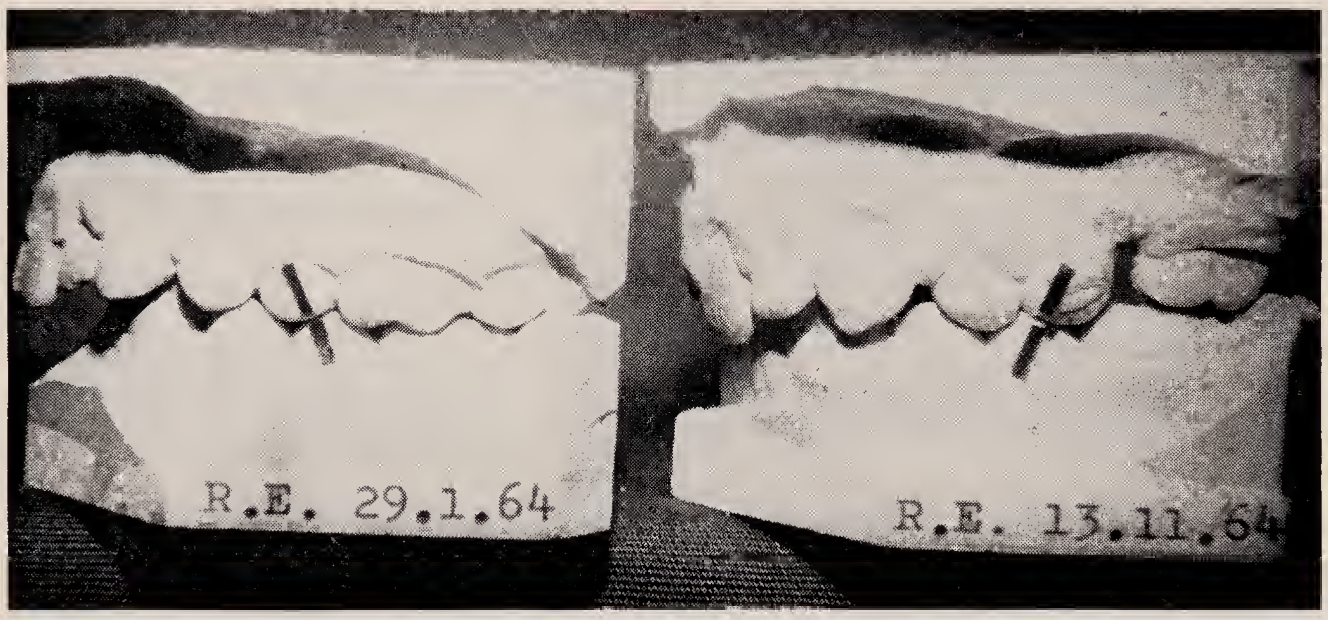


Fig. 7.—Same case as *Fig.* 5. |6 had to be extracted. Free-sliding arch 61|15 used to retract 1|1 and tilt |5 distally. |4 has followed |5 naturally.

Reference has been made earlier to the important clinical characteristic of the Watkin free-sliding arch that, when activated to retract incisors, there is absence of any reaction drawing the buccal segments mesially. Physiological mesial drift will, however, still occur but, if necessary, this can be neutralized by incorporating a mild 5° tip-back bend to the section of the which is arch lying in the posterior tubes (*Figs.* 5, 6).

Taken one stage further a similar tip-back bend, adjusted in an arch attached to the two second premolars, will produce distal tipping of the premolar crowns. Thus, using lever-torque and posterior tip-backs, retraction of two incisors and distal tilting of two premolar crowns may be carried out simultaneously (*Fig.* 6). On the face of it, this would seem to defy Newton's laws of motion, but on analysing the forces involved it will be seen that the anchorage is found in the incisor root area. The reaction from the premolar tip-back bend supplements the depressing force on the incisors, so it is vitally important that the lever-torque activation be reduced by half and that the angulation of the tip-back does not exceed 5–10° in relation to the long axis of the posterior tube.

This appliance has obvious advantages in mild Class II, division 1 cases where unavoidable loss of the two upper first molars before the eruption 7|7 would otherwise mean delay in moving the premolars distally with subsequent loss of all 6|6 space (*Fig.* 7).

Class II, Division 2 Incisor Relationship

The two-stage retraction of four incisors involves moving 1|1 first, converting a Class II, division 1 incisor relationship virtually into one of Class II, division 2 as 2|2 are left temporarily proclined. The bands 1|1 are removed and a new arch fitted on 2|2. The adjustment procedure for the retraction of 2|2 is almost the same as for retraction of 1|1. One important practical point to observe is that the section of the arch lying between the lateral incisor loops must stand clear of the labial surfaces of the central incisor crowns. The activation should be reduced slightly to compensate for the smaller lateral root surface area.

Class III Incisor Relationship

An interesting example of the versatility of this appliance is apparent when exactly the same arch design that has been described to treat Class II cases, can be used to correct incisors in a Class III relationship. The only change necessary to produce moments of force moving the incisor crowns forwards, is in adjusting the posterior free-ends of the arch to lie passively above instead of below the posterior tubes.

The Force diagram (*Fig.* 8) shows a supracluding force on the incisors and a depressing force on the molars. Both these forces are beneficial in the treatment of Class III cases with a reduced incisor overbite. In comparison with conventional appliances, which often unfavourably depress the incisors during labial movement

over the bite, the Watkin free-sliding arch gently increases the incisor overbite, thus improving the prognosis for incisor stability. This reverse

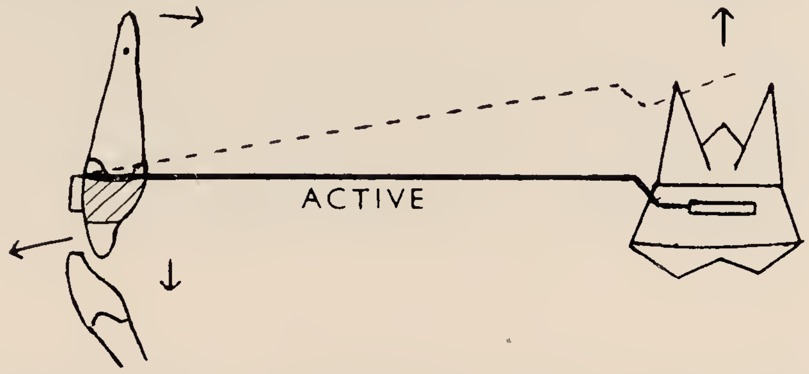


Fig. 8.—Force diagram. Arch adjusted to lie passively above molar tube. Free-sliding arch 61|16. Class III case.

loop angulation of approximately 10° to the incisor tubes when the arch is inserted into the posterior attachments. Over-rotation is easily achieved.

Intra- and Intermaxillary Traction

Being endowed with free-sliding characteristics, the appliance is readily adapted for both intra- and intermaxillary traction. A hook bent into the arch wire in the canine region provides an anterior attachment for the elastics. When taken distally for intramaxillary traction to close residual spacing, the elastic is placed round the free-end of the arch, which is allowed to protrude slightly from the posterior tube. The free-end is bent inwards to avoid mucosal trauma.

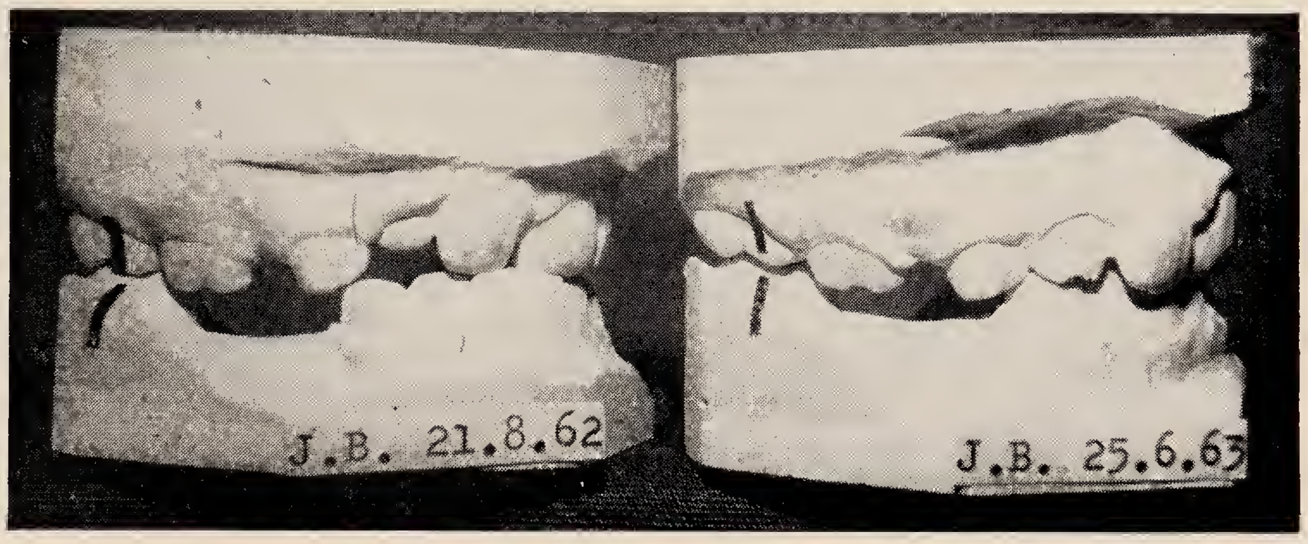


Fig. 9.—Class III case with rotated 1|1 treated with ‘ reverse ’ free-sliding arch. Active treatment began on 8 Jan., 1963.

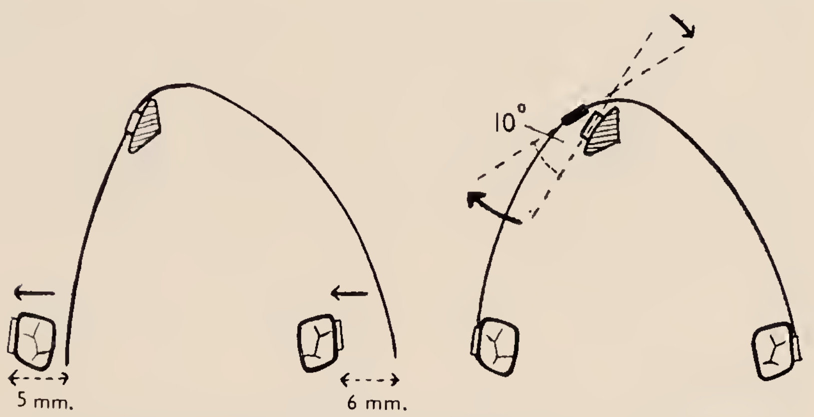


Fig. 10.—Adjustment diagram for rotating an incisor. Free-sliding arch 61|6 to rotate 1|.

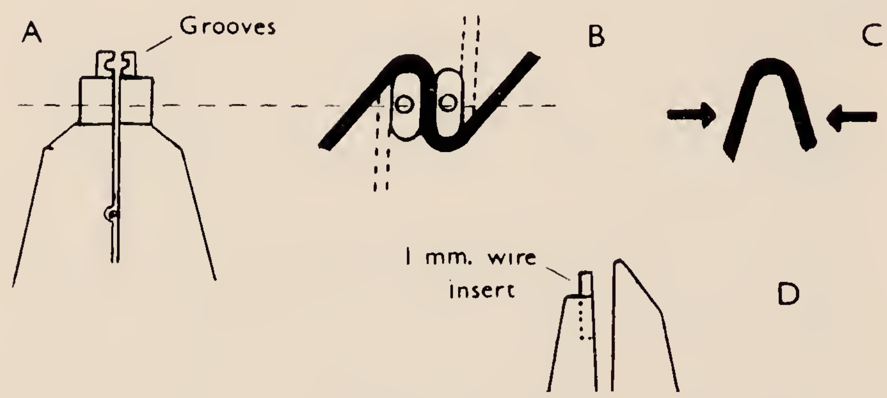


Fig. 11.—A, Watkin loop-forming pliers; B, C, Cross-section of loop-formers, and loop construction; D, Watkin coil-forming pliers.

free-sliding arch is therefore particularly useful in the treatment of mild Class III cases where the incisors are rotated and exhibit a reduced incisor overbite (*Fig.* 9).

Rotation of Incisors

Lever-torque can also be applied laterally, creating torsion which will rotate a tooth round its long axis.

Fig. 10 shows the activation required for an average-length 61|6 arch to rotate 1| distolabially. A slightly greater deflexion is given in this case to the left side of the arch due to its longer arch span. This adjustment produces an incisor

For intermaxillary traction using a free-sliding arch, for example with a lower multiband appliance, the elastics are attached in a similar way. Anteriorly the incisor loops should fit loosely in the box-tubes and may be left unlocked so that the vertical component of the elastic force does not produce incisor elongation.

CONSTRUCTION

1. The Arch

Average length free-sliding arches are constructed from 0·45 mm. hard stainless steel or 0·018 in. high-tensile wire unless the arch span is

less than 2 cm. in length, when 0·35 mm. hard stainless steel or its high-tensile equivalent is recommended.

The anterior section of the arch with its loops and coil is made first. The loops may be formed with Adams' or Angle's spring-forming pliers but the operation is facilitated by using the new Watkin loop-formers* which are designed to produce loops which fit accurately into commercially obtainable box-tubes.

Fig. 11B shows a cross-section of the new Watkin loop-formers and illustrates loop formation. The sides of the loops are made parallel by squeezing each loop between the grooves which

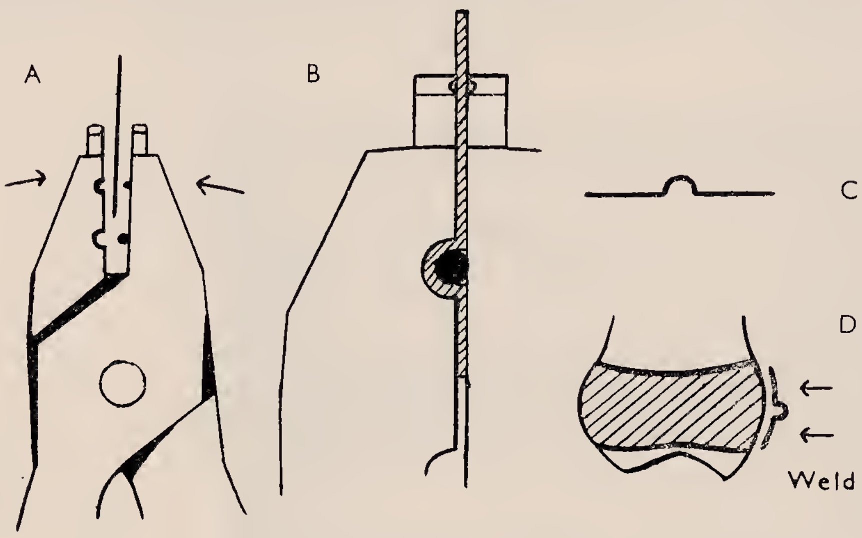


Fig. 12.—A, B, Molar band tape pressed between 0·6 mm. wire and groove; C, Groove formed in tape; D, Tape welded to band-forming tube.

have been machined at the tips of the pliers (*Fig.* 11A).

Spring-forming pliers are recommended for shaping the rest of the arch, forming the crank, angling the loops, and for producing coils or traction-hooks.

The coils should be of small diameter. In practice we use spring-forming pliers, one beak of which is modified to take a short length of 1 mm. hard stainless steel wire inserted tightly into a previously drilled hole (*Fig.* 11D). An extremely neat coil may be wound round this wire insert, which has an excellent resistance to wear but could, if necessary, be easily replaced.

The arches are made to plaster models but extreme accuracy at this stage is unnecessary. A stock of arches can be constructed and drawn on when required. Accurate adjustment and crank positioning are carried out easily and quickly at the chairside.

2. The Attachments

Incisor box-tubes complete with locking-tongues are obtainable in strips from which individual tubes are cut and welded to the labial surface of the incisor bands. Leighton's method of loop-locking can be used, but we have found the tongue method more convenient.

The posterior tubes are simply made by pressing a piece of molar band tape (5·0 × 0·15 mm.) between the appropriate 0·6 mm. wire and groove which are found on the Watkin loop-formers (*Fig.* 12). The grooved tape is welded to the molar band, producing a tube of approximately 0·5 mm. internal diameter through which the 0·45 mm. arch wire may freely slide.

INSERTION AND REMOVAL

Assuming, following the diagnosis, that the treatment plan is settled, bands are pinched at the end of the patient's first visit. This enables the bands to be completed, attachments welded, and the arch made ready for insertion at the second visit. Circumstances sometimes call for an immediate one-visit insertion of an appliance. Four bands can be made, inserted, and a free-sliding arch bent up at the chairside whilst the band cement is setting. The whole operation can be completed in under 30 minutes.

Periodic adjustment is advisable on average every 7 weeks, although some arches left unadjusted for longer periods will often be found to have some degree of activation remaining. The excellent range of movement of the long arches is therefore an important feature of the appliance, making it suitable for patients who may be away at boarding-school for 12 or more weeks.

The arch is very simply unlocked by elevating each incisor locking-tongue with a narrow plastic instrument or scaler inserted into each box-tube from below. Following withdrawal of the loops the whole arch is removed for cleaning and adjustment by sliding it forwards out of the posterior tubes.

SUMMARY

The principles of the Watkin free-sliding arch have been described. When adapted to use lever-torque, its ability to carry out retraction or labial movement of incisors with simultaneous correction of rotations and approximation or dispersion of crowns and/or root apices along the arch has been demonstrated. The absence of any reactive force drawing the maxillary buccal segments mesially during incisor retraction has been stressed.

The appliance is simple yet versatile, easy to construct at the chairside if necessary, and quick to remove, clean, adjust and reinsert. It possesses a good range of movement and therefore requires comparatively infrequent adjustment. It has been found to be particularly suitable for use in orthodontic practice under the General Dental Services.

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* Watkin loop-forming pliers and strips of box-tubes with tongues are obtainable from Elliotts (Liverpool) Ltd., Buckland Street, Liverpool 17.

I would like to thank H. G. Watkin for introducing me to the free-sliding arch some years ago and for his help and encouragement in producing this paper.

REFERENCES

Angle, E. H. (1916), *Dent. Cosmos.*, **58**, 988.
de Coster, L. (1935), *L'Orthodontie a Base D'Acier*, 1st ed. Paris: Masson.
Jackson, V. H. (1904), *Orthodontia*, 1st ed. Philadelphia: Lippincott.
Leighton, B. C. (1963), *Trans. Brit. Soc. Orthodont.*, 106.
McCoy, J. D. (1927), *Int. J. Orthod.*, **11**, 493.
Watkin, H. G. (1933), *Trans. Brit. Soc. Orthodont.* (Presidential Address).
—— Watkin, P. A., Clifford, E. J. S., and Murray, J. P. (1958), *Ibid.*, 105.

DISCUSSION

Mr. B. C. Leighton, opening the discussion, said that he could not help seeing the appliance as a particularly versatile form of multiband. Its ability to align the incisors could not be ignored as long as more than one of those was banded. It was inevitable that when the arch was first inserted, local tooth movement of incisors would occur unless extreme care was taken to render the loops quite passive. If bracket engagement was absolutely secure, then the initial force need not be a tipping one and would therefore be less likely to be excessive. If tipping were permitted initially, it was important to start with a gentle force. This was a real danger with the round and twin wire arch. Firm engagement of the brackets made it possible to distribute the force along the full length of each root.

He asked Mr. Clifford if he ever used three coils between brackets. He was not too happy, even with 0·35 mm. wire, to use only one coil if the teeth were very irregular at the start of treatment.

As Mr. Clifford had said, by using high-tensile wire, it was possible to increase the range of movement. He wondered if this was not at times a double-edged sword. Could there not be danger of over-retraction of upper incisors into a damaging occlusion?

Mr. Clifford had described the basic principle of the appliance, namely lever-torque, in a way which everyone understood. He thought that many would be surprised to see that treatment of a Class II, division 1 case started with retraction of the central incisors. With most other appliances it was usual to retract teeth in the buccal segments first of all to make space for retraction of incisors. He asked Mr. Clifford if he would describe the sequence of treatment for a Class II case with no spacing, or even a little crowding, as well as proclination of the upper incisors. Did he use the local pin-and-tube appliance described by Watkin for the retraction of canines, or did they always follow the premolars?

He found the spontaneous movement of first premolars following distal tipping of second premolars a most interesting aspect of this appliance. Had Mr. Clifford found that the canines were similarly affected?

One of the difficulties he had found with the sheathed arch was its tendency to rotate in the molar tubes when lever-torque was used. This was likely to be prevented in the Watkin arch by the crank bend almost in front of the molar tube, particularly when the incisors were being retracted. Was it found that this was a problem with proclined incisors when the tendency would be to rotate outwards?

He was surprised to hear that Mr. Clifford left incisor loops free in their boxes when using Class II intermaxillary traction. Did he not find occasionally that these loops came right out of their boxes, the patient being left with the arch loose in his mouth?

Mr. Clifford said that he had not found it necessary to use more than one coil. The main object was to keep the adjustment in the molar tubes slight and not over-adjust.

Following distal movement of $\underline{3|3}$, central incisor retraction was carried out first because the arch had some influence on $\underline{2|2}$, the effect of which was to reduce the time of active treatment on $\underline{2|2}$ later.

On the subject of rotation in the molar tubes, he had not noticed this but would look for it. Certainly it had not had any adverse effect on the central incisors that had been retracted.

Perhaps he was rather cautious in having his loops loose in their boxes when doing intermaxillary traction. He had not found appliances coming out through this.

Miss J. P. Murray agreed that it was often necessary, in treating a case of superior protrusion, to extract the first molars. With this appliance it was usually possible to move the second premolars distally, but occasionally the second molars drifted forward and prevented this. How would Mr. Clifford deal with this situation?

Mr. Clifford said that if the third molars were not present, perhaps extra-oral traction could be used, or the extraction of another premolar. He did not like doing this, but it was sometimes unavoidable.

Mr. A. E. Fisher noticed that all the examples shown were in the later dentition after eruption of molars and canines; there were none in mixed dentition. Would Mr. Clifford consider early use of the Watkin appliance practicable?

Mr. Clifford said that this was used in mixed dentition if there was sufficient spacing to retract the incisors, and also if the soft-tissue morphology and behaviour were favourable.

Mr. B. S. Cryer noted that Mr. Clifford's diagrams all showed an incomplete incisor overbite at the commencement of treatment. Did Mr. Clifford alter the procedure if there was a complete overbite with an overjet? He wondered if perhaps this could account for what seemed to be a rather deep overbite at the completion of treatment in the examples shown, although a reduction of overbite was shown to be more likely from the way the torque was placed on the tube.

Mr. Clifford replied that when it was used for retracting incisors there was certainly a tendency for the incisors to be depressed. Most of the models he had shown on the slides were out of retention and any depression of the incisors tended to revert and come down to such a position on the inside of the lower lip

dependent on the interaxial angle of the incisor occlusion after retraction.

Mr. C. D. Parker said that Mr. Clifford had stated that there was no movement of the crowns of the upper first molars as the central incisors were retracted. Was there any mesial movement of the apices of the first molars and, if so, did this cause any trouble later? Were the upper second premolars ever removed to allow the upper first molars to upright?

Mr. Clifford said that, clinically, he did not think it was particularly significant. He doubted if there would be very much movement of molar apices because of the increased surface root area of the molar roots compared with the incisors. Very slight activation was used with these appliances. If the appliances were over-activated, there would probably be some apical movement of the molars.

Mr. H. G. Watkin thanked Mr. Clifford for doing a job which he himself should have done 10 years ago. The chief use of that crank in the wire was to get the arch wire away from the occlusal surfaces of the teeth to avoid distortion on mastication.

Dr. J. R. E. Mills said that a small number of cases in Class II, division 1 had been analysed on lateral skull radiographs at the Eastman Dental Hospital, and he had the impression that there was some labial movement of the apices, even more than Mr. Clifford got. He did not think that this was due to over-activation; it could occasionally be very useful. There was a certain type of Class II, division 1 case which was associated with a very shallow lower facial height where the apices of the upper incisors were a long way palatal, and with that type of case, the pin-and-tube was the only way he knew of treating it.

Mr. Clifford said that apparatus was not available to him in practice to measure movement of apices. Clinically, this was rarely seen unless the arch had been distorted and therefore over-activated.

EXTRA-ORAL TRACTION

THEORETICAL CONSIDERATIONS AND THE DEVELOPMENT OF A REMOVABLE-APPLIANCE TECHNIQUE

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W. J. CLARK, B.D.S., D.D.O.

THE potential of treatment by extra-oral traction to produce distal movement of teeth in the upper arch has not yet been fully realized, and it appears to be inevitable that extra-oral techniques will be refined and improved, and will come to be used very much more extensively than they are at present.

In all orthodontic tooth movement early consideration has to be given to choice of anchorage. Before using intra-oral anchorage the reciprocal forces thus created must be taken into account, and in many cases these are of an undesirable nature. Fischer (1952) states that ' intra-oral stationary anchorage is a myth even with " prepared " anchorage ', and stresses the necessity for ' independent, selective, and individual tooth movement which can seldom be carried out by intra-oral reciprocal forces alone '. To carry out ' selective independent tooth movement, the use of intramaxillary force and intermaxillary force is confined to desirable reciprocal tooth movement, and extra-oral force is used whenever reciprocal tooth movement is contra-indicated '.

Failure to appreciate the nature of these reciprocal forces has, in the past, been responsible for many orthodontic catastrophies. The inadequacy of mandibular anchorage in Class II cases has resulted in the inadvertent production of bimaxillary proclinations, or severe imbrication of lower incisor segments. It was because of these ill effects that Tweed (1941) first observed the importance of retaining the correct relationship of the lower incisor teeth to the ridge and to the mandibular plane. Ballard (1951), on the other hand, related the limitations of labial movement of the lower incisors to soft-tissue morphology and behaviour. Tweed and Ballard independently condemned the indiscriminate proclination of lower incisor segments during treatment, but differed in their approach to aetiology and prognosis. Tweed reached his conclusions by cephalometric appraisal, while Ballard took into account both the soft tissue and the skeletal pattern.

Tweed developed his own technique of ' prepared ' anchorage to overcome the reciprocal effects of intermaxillary traction. This technique involves the banding of all permanent teeth, including the second permanent molars, and requires the application of very carefully equalized degrees of torque and tip-back bends to labial and buccal segments respectively. Anchorage is prepared in the lower arch by supplementing this appliance with Class III elastics which are worn continuously, together with extra-oral traction at night. Finally, Class II elastics are applied and, in the hands of an experienced operator, the results are undoubtedly excellent.

Clinical considerations apart, the very complexity of this technique limits its application to a very small stratum of society, particularly in this country. Despite the great expertise involved, some words of Jackson (1947) are not inappropriate in this context:—

> On general principles, the simpler the appliance and the more perfect its adaptability to the correlation of movements of the jaws and the opposing teeth, the better the treatment. There are some appliances that, by their sheer intricacy in the effort to do too many things at the same time, defeat their own purpose.

The refinements to counteract the unwanted reciprocal forces in intermaxillary traction are indeed intricate, and the simpler alternative is a greater use of extra-oral traction itself. A considerable movement in this direction has resulted from the difficulty of producing stable results in many cases treated by intermaxillary traction, and from an appreciation that many of these failures are due to the inadequacy of simple mandibular anchorage. The use of extra-oral anchorage has become increasingly popular, although, as Marx (1960) pointed out, it was first used as far back as 1822. Fischer (1952) has fully explored the use of extra-oral traction in his technique of sectional treatment with fixed appliances, and in this country McCallin (1953,

Presented at the meeting held on 8 March, 1965.

1961) has been concerned particularly in the development of traction with removable appliances.

It is perhaps fair to say that these authors represent the application of extra-oral traction in the fixed appliance and removable appliance fields respectively; and as removable appliances are of particular relevance in this country, it is proposed to discuss these in rather more detail. In the first place, however, it is worth while enumerating the ideal requirements of a removable extra-oral appliance, before considering the types of appliance which are in common use, and the scope for improvement or simplification in their design and technique. These requirements would include the following:—

Fig. 1.—High-pull traction with head cap.

1. Easily made with apparatus and materials normally available.
2. As easily fitted and adjusted as other types of removable appliance, and economical in surgery time and frequency of visits.
3. Able to provide control of all tooth movements involved.
4. Non-traumatic.
5. Able to be worn both day and night, so that cuspal interference can be eliminated without the provision of a separate bite plate.
6. Direction of extra-oral force should be so arranged that retention of the appliance is assisted rather than defeated.
7. The appliance should be able to deal with a wide range in the choice of extraction, or of missing teeth, and also of stage of eruption.
8. The extra-oral gear should be simple and robust so as to present no great difficulty to the patient.
9. The entire appliance should be comfortable and acceptable to the patient.
10. All parts of the appliance should be capable of simple repair or replacement.

All extra-oral traction appliances can be divided into their intra-oral and extra-oral components. Extra-orally, the chief difference lies in the angle of the pull exerted. Cervical, or low-pull, traction has the disadvantage of exerting a downward displacing force on an upper appliance, and is not as satisfactory as occipital traction in this respect, particularly where retention is poor. The downward force will, however, assist in the retention of a lower appliance. On the other hand, occipital, or high-pull, traction can assist the retention of an upper appliance if the direction of force is precisely controlled. High-pull is best provided by a headcap, but functionally, there is no advantage in fitting the full Chapman type, and a curtailed version is better tolerated by the patient (*Fig.* 1).

The intra-oral appliances are distinguished chiefly by the method of attachment of the facial extensions. Where these are fixed, the appliance can be worn only at night, and the occlusal forces during the day can severely reduce the rate of progress. To overcome these antagonistic occlusal forces in cases where the error is greater than half a cusp, a lower bite-raising appliance can be used, but the risk of an increase in the incisor overbite is undesirable, even if it proves to be only temporary. McCallin (1953) describes a removable appliance with a detachable labial bow carrying 'whiskers' for traction. The 'whiskers' themselves fit into tubes which are soldered to the clasps on the upper first premolar teeth. The appliance is designed to be worn full time, and in conjunction with a lower appliance with which to apply intermaxillary traction during the day. Later, in 1961, the same author describes a modification of this appliance in which the 'whiskers' are rigidly attached to a fixed labial bow; and he goes on to report that 'this method of attaching the extra-oral "whiskers" on to the labial bow instead of inserting them into tubes on the buccal clasps is more rigid and overcomes a tendency for the clasp to become distorted with loss of appliance anchorage'. It is recommended that this appliance should be worn for 'ten or if possible twelve hours in twenty-four'.

The type of extra-oral attachment which is in most common use consists of facial arms, which are extended from a cervical tube and which hook on directly to loops incorporated in the labial bow in the lateral incisor position. The advantage of this design is that it is possible for the intra-oral appliance to be worn full time during the day, and a bite platform can be added to eliminate unwanted occlusal interference. But the downward displacing force inherent in cervical traction

is a disadvantage, particularly as the point of application of the extra-oral force may lie outside the limit of anchorage of the appliance, and the displacing force is therefore bound to act with some leverage.

With these various difficulties in mind, it has been found that they can be satisfactorily overcome by designing an appliance in which the facial arms are inserted into tubes, which are themselves an integral part of the acrylic base plate, and by using with this appliance an occipital or high-pull, rather than a cervical or low-pull traction. The facial arms, or ‘whiskers’, are detachable by day and are readily inserted by the patient at night, traction being applied by rubber bands passing to the buttons on the headcap. The plate itself is worn continuously both day and night, including mealtimes, and is removed for cleaning only. The anterior bite platform eliminates cuspal locking, and can be used to reduce the incisor overbite. A midline expansion screw is normally included to provide the lateral expansion which needs to take place concurrently with distal movement of the upper buccal segments (*Figs*. 2–4). At the chairside it is found that the simplest routine is to fit the intra-oral appliance first, and to carry out lateral expansion for a few weeks before adding the extra-oral attachment. Initially, the labial arch is passive in order to concentrate the extra-oral force on the buccal segments, and is activated only when correct cuspal relationships of the premolar teeth have been established. In comparison with a fixed-appliance technique, there is an appreciable saving in chairside time and in the number of visits; adjustment being required no more frequently than with many other types of removable appliance.

Fig. 2.—1·0-mm. facial arms in 1·0-mm. internal diameter tubes—case prepared for cold-cure resin.

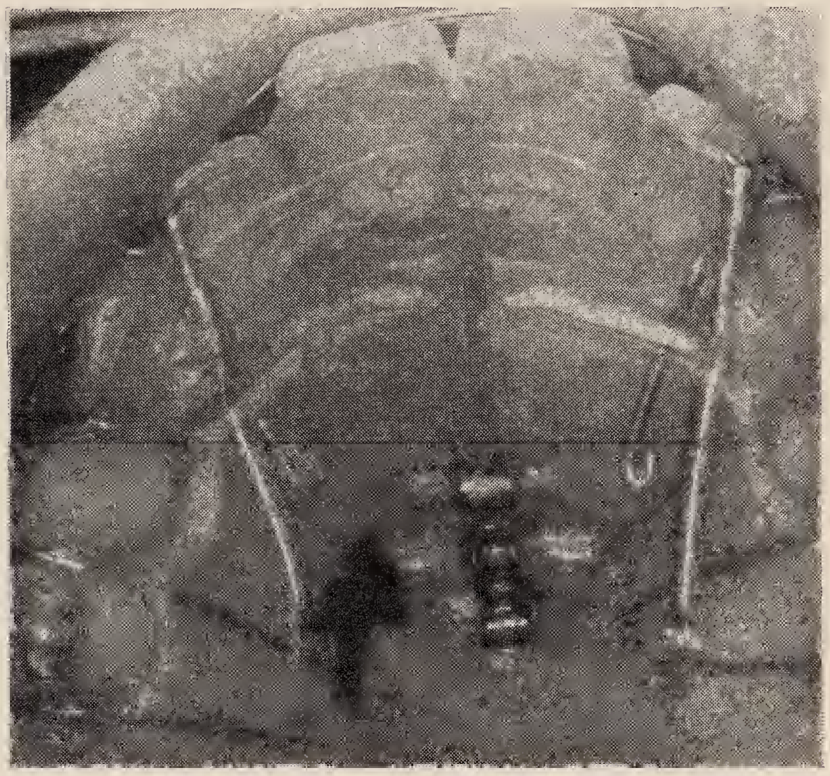

Fig. 3.—Intra-oral view showing tubes and screw.

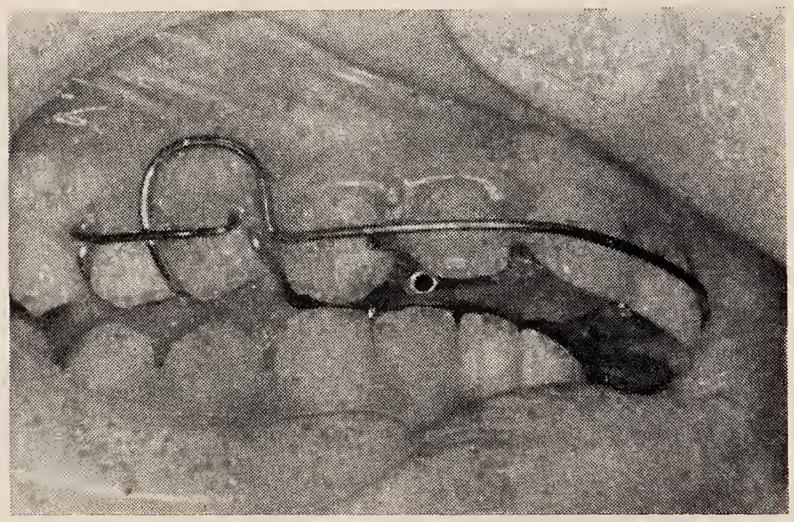

Fig. 4.—Lateral view showing 54| crib, 0·7-mm. labial arch and exit of 1·0-mm. internal diameter tube.

It is found that the appliance is easily handled by the patient, and in fact co-operation is often enhanced because the patient is not only participating in his own treatment, but is able to see and understand the mechanics involved. The assembly and disassembly of the facial arms is of course done outside the mouth, which is of considerable advantage. Mistakes in handling the attachment are found to occur less frequently than in routine handling of expansion screws. A severely spastic case is managing well, with the help of a capable parent.

INDICATIONS FOR USE

The indications for extra-oral traction with the technique described may be subdivided as follows:—

1. (*a*) Class II cases where traction is required in the upper arch only. (*b*) Class II cases where anchorage for intermaxillary traction is not available.

2. (*a*) Class I cases in which excessive mesial drift of buccal segments has occurred with production of anterior crowding. (*b*) Class I cases in which excessive mesial drift of buccal segments has contributed to bimaxillary proclination. (*c*) To reinforce anchorage.

3. To move buccal segments distally when relief of overcrowding by extraction of (*a*) $\underline{6|6}$, or (*b*) $\underline{7|7}$ is indicated, or (*c*) where absence of $\underline{8|8}$ can provide sufficient relief to contra-indicate extraction more mesially.

a. Many cases are complicated by a poor conservative prognosis for the first permanent molars, or have already lost some or all of these teeth prior to being referred for orthodontic treatment. The possession of a relatively simple means of moving the buccal segments distally in these cases, a method which is independent of the second permanent molar teeth which have often drifted mesially either before or after eruption, makes it possible to avoid the major disadvantage of this all too frequent set of circumstances.

In a large number of cases, therefore, the orthodontist is provided with a greater freedom of choice of extraction.

Case 1 (*Fig*. 5).—H. H. presented at age of 14 years 8 months, with a moderately severe Class II pattern with an incisor overjet of 11 mm. The muscular pattern was good but $\frac{6|6}{6|6}$ had been lost previously and severe mesial drift of $\frac{7|7}{7|7}$ had occurred.

Extra-oral traction was used for 14 months, and the overjet reduced to 4 mm. The case is stable after 2 years out of retention.

Case 2 (*Fig*. 6).—A. M. presented at age of 12 years 9 months, with a moderate Class II pattern and an incisor overjet of 9 mm. The muscular pattern appeared to be satisfactory, but $\frac{6|6}{6|6}$ had been lost 2 months previously. The lower premolar teeth had not yet erupted.

Upper removable appliances with extra-oral traction were used over a period of 13 months and the overjet reduced to 4 mm. The case is stable 2 years out of retention.

b. Where relief of crowding is unavoidable, but the first permanent molars are sound, and it is unwise to break the arch in the premolar region, the choice falls ideally on the second permanent molar teeth. Distal movement of upper buccal segments is required, but if reciprocal movement in the lower arch is contra-indicated, the use of extra-oral traction is the only sound alternative. Furthermore this choice of extraction very often arises in the milder type of case where the amount of movement required is relatively small and hardly justifies the use of a full fixed-appliance technique.

Case 3 (*Fig*. 7).—D. L. presented at age of 11 years 11 months, with a moderate Class II pattern and slight anterior open bite. A slight lisp was noticed, but there was a history of thumb sucking to the age of 7 years. The lips were competent but of low tonus. The incisor overjet amounted to 10·5 mm.

$\underline{7|7}$ were removed and removable appliances with extra-oral traction used over a period of 8 months. The overjet was reduced to 3·5 mm. and the case is stable 2 years out of retention.

Case 4 (*Fig*. 8).—V. G. presented at age 16 years 9 months, with a moderate Class II pattern, with an incisor overjet of 8 mm.; but with a tooth-apart swallowing action, a pronounced mentalis muscle action, and barely competent lips. She had been treated some years previously with intermaxillary traction but had relapsed.

$\underline{7|7}$ were removed and upper removable appliances with extra-oral traction worn over a period of 12 months. The overjet was reduced to 3·5 mm. and stability is good after two years out of retention.

c. Absence of the third permanent molar teeth, in some of the milder cases of tooth/tissue discrepancy, makes it possible to relieve imbrication or excess overjet without recourse to extraction more mesially in the arch.

CONTRA-INDICATIONS AND DIFFICULTIES

No appliance or technique is of universal application, and the present method of applying extra-oral traction has several limitations. Some of these are inherent in the type of traction, and others in the particular form by which it is applied.

1. Discontinuity

This factor is common to all removable appliances, but is of particular importance where the application of force is part time only.

2. Time

All forms of extra-oral traction, by their intermittent nature, are slow, and the rate of progress usually compares unfavourably with, for instance, intermaxillary traction with fixed appliances. This applies particularly in those cases where ‘ gagging ’ of the bite fails to be maintained because of rapid reduction of incisor overbite. In these cases the effect of heavy cuspal locking can affect the rate of progress very adversely, and selective stoning of abnormally steep cusps may be needed. Excessively pronounced lingual cusps of upper first premolar teeth are the most frequent difficulty in this respect.

3. Axial Inclinations

The distal shift of upper buccal segments involves a large measure of tipping movement. The ideal response is obtained with the present technique in those cases in which mesially tipped buccal segments are to be uprighted. Conversely, segments which are already tipped

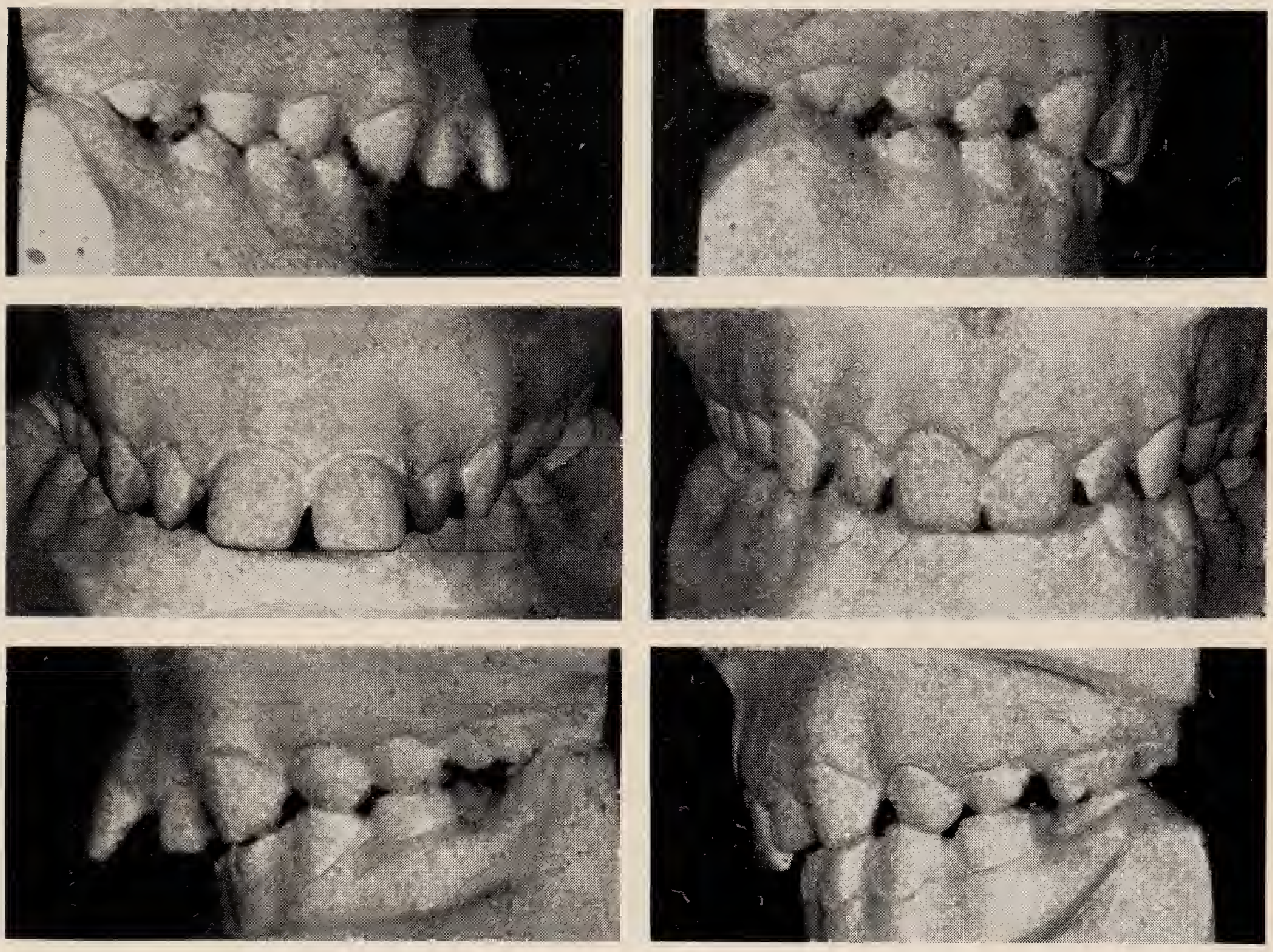

Fig. 5.—*Case* 1. Study models before treatment and after 14 months' traction.

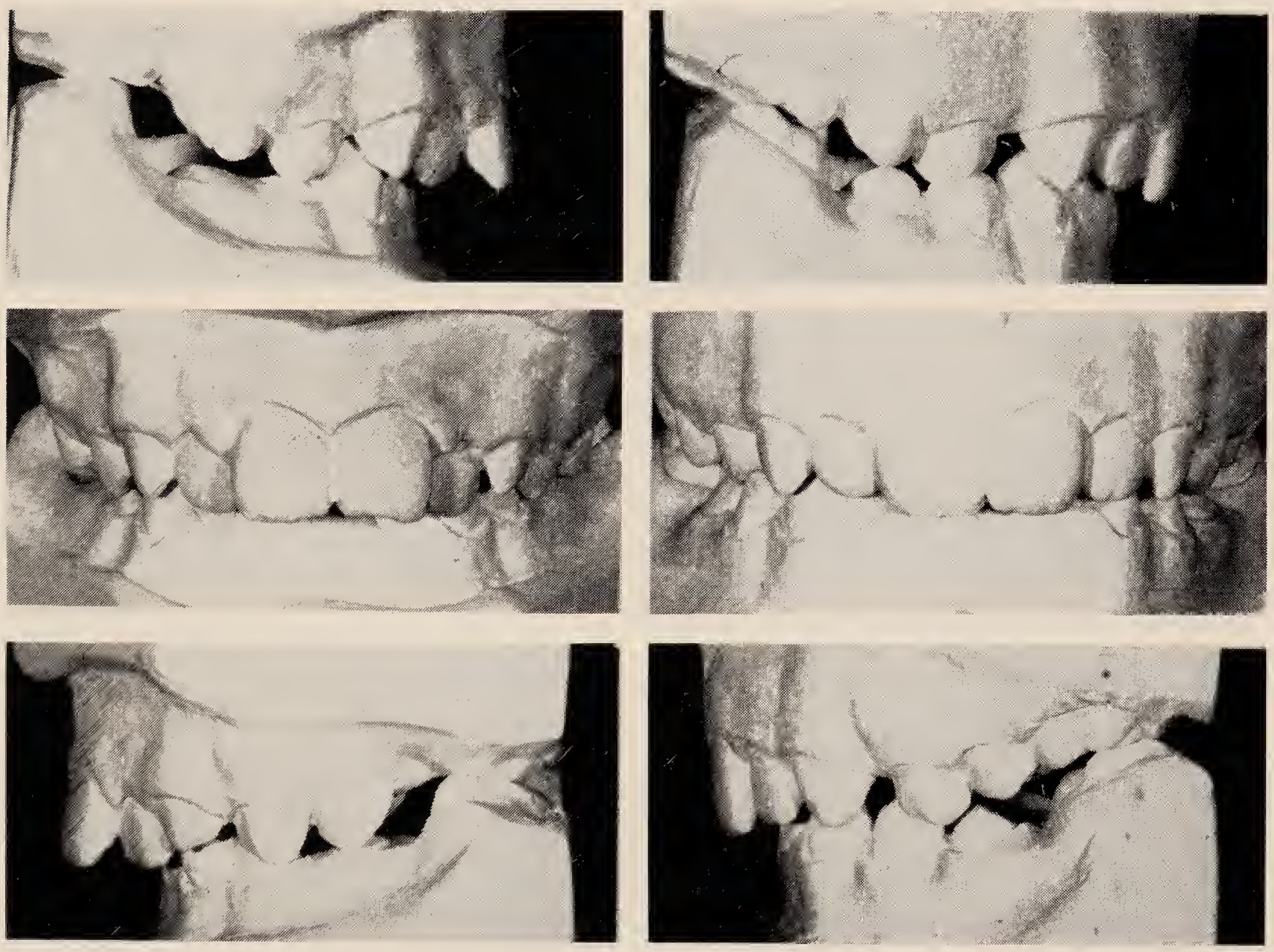

Fig. 6.—*Case* 2. Study models before treatment and after 13 months' traction.

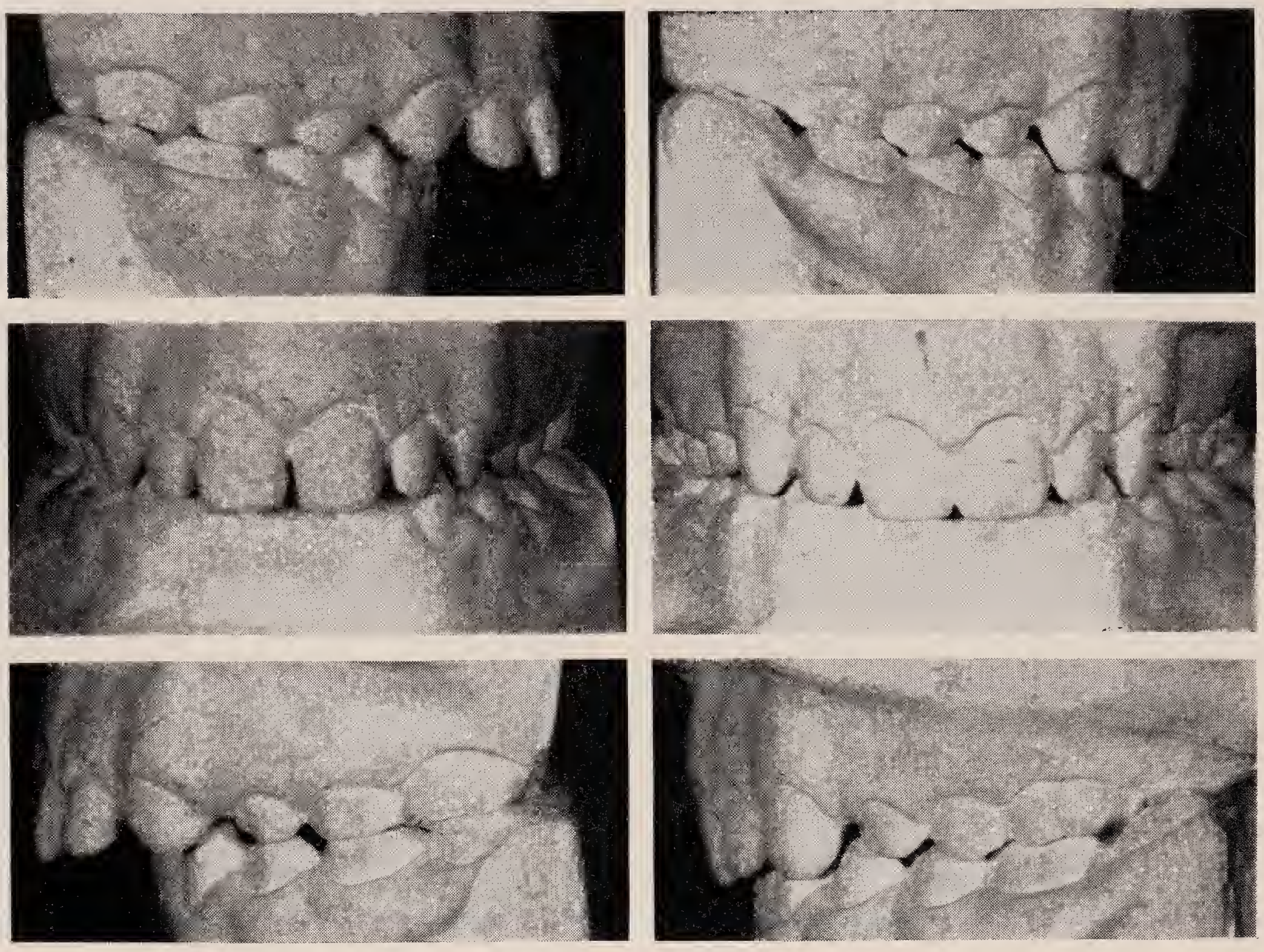

Fig. 7.—*Case* 3. Study models before treatment and after 8 months' traction.

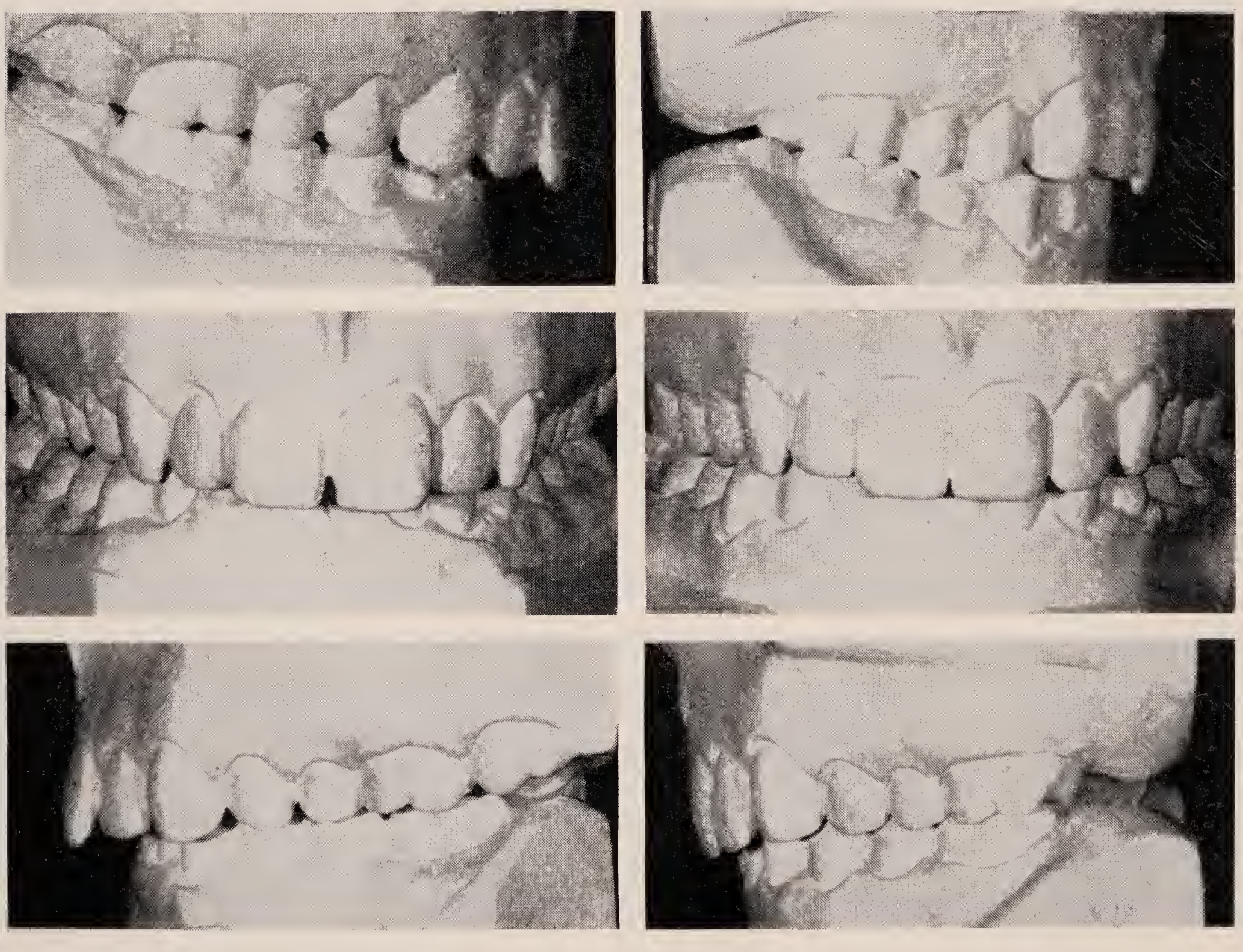

Fig. 8.—*Case* 4. Study models before treatment and after 12 months' traction.

distally offer a relatively poor prognosis. Where distal tipping of premolar teeth is apparent, any relief of crowding should be carried out as far forwards in the arch as possible, and alternative appliances used. Clinically, however, it is very much more common to find some degree of mesial tipping, and in these cases the prognosis is favourable for extra-oral traction.

4. Asymmetry

It is difficult to provide asymmetrical or unilateral force with extra-oral traction, and the present technique is best suited to those cases in which entirely symmetrical distal shift of buccal segments is required. Only slight variations of force between one side and the other can be introduced with any degree of reliability.

5. Anterior Open Bite

Careful consideration of the aetiology of an anterior open bite is essential in any form of appliance treatment, but is of particular significance with the present technique because it is found that the distal tipping of the upper buccal segments tends to reduce the degree of incisor overlap. While this is an advantage in the majority of Class II cases, and no disadvantage in Class I cases, it is a contra-indication where an anterior open bite is caused by skeletal or endogenous muscle behaviour pattern; but the same limitation would apply to treatment by intermaxillary traction.

6. Reciprocal Movements

Extra-oral traction has nothing to contribute to those cases in which reciprocal force only is indicated, and intermaxillary traction remains the technique *par excellence* for a small proportion of Class II cases.

However, in those cases where the reciprocal forces required are not accurately balanced, the technique described can offer a convenient method of supplying the proportion of non-reciprocal force that may be indicated.

SUMMARY

The use of inter- and intramaxillary traction is severely limited, particularly in Class II cases, by the production of undesirable reciprocal forces. The use of extra-oral traction overcomes this limitation, and the wide indications for this type of traction are discussed. Variations of technique and a new appliance design are described, together with some examples of treated cases.

Acknowledgements

We are indebted to Professor T. White, Advisor of Studies, Glasgow Dental School, and to Mr. A. Cockburn, Consultant Orthodontist, Glasgow Dental Hospital, for very helpful criticism of the text of this paper; to Mr. J. L. Taylor for the technical appliance work; and to Mr. I. Murray, of the Glasgow Dental Hospital for his photographic assistance.

REFERENCES

Ballard, C. F. (1951), *Trans. Brit. Soc. Orthodont.*, 37.

Fischer, B. (1952), *Orthodontics: Diagnosis, Prognosis, Treatment.* Philadelphia: W. B. Saunders Co.

Jackson, A. F. (1947), *Dent. Rec.*, **67**, 275.

McCallin, S. G. (1953), *Trans. Brit. Soc. Orthodont.*, 104.

— — (1961), *Ibid.*, 77.

Marx, R. (1960), *Ibid.*, 77.

Tweed, C. H. (1941), *Amer. J. Orthodont.*, **32**, 175.

DISCUSSION

Mr. S. G. McCallin said that one of the first things the speaker observed was that extra-oral traction produced a distal movement of buccal teeth. Many of those present would know that much work had been done to try to confirm this, the idea being that, in many cases, the relative changing position of the buccal teeth in the upper arch was the result of the growth of the maxilla past the held buccal teeth.

He was disappointed that the authors had said nothing about early treatment in mixed dentition. American workers were very keen on this and all showed rather spectacular changes resulting from the application of extra-oral traction early.

The appliance itself was a very original idea to him and, superficially, he would think it was extremely useful. He was a little concerned, however, with the idea of so much material being worn in the patient's mouth for twenty-four hours. An extremely large bite plane appeared to be on all these appliances, and he wondered if the patients found these difficult to tolerate. He did not know whether the thickness of the bite plane was necessary to incorporate the tubes for the insertion of the extra-oral arms or not. He would like more information on that.

Reference was made to cuspal interference. He never had any trouble with cuspal interference. He knew he had been guilty of suggesting that it was a good plan to start with intermaxillary traction from the lower arch; he wished he could withdraw that from print because he thought that the Class II intermaxillary traction was one of the greatest problems and caused more trouble than anything else that was done.

The authors said that they expanded before they started to move the buccal teeth distally. He would have thought that this would have pushed the buccal

teeth out against the buccal plates and made it difficult for them to move distally. He wondered why they did that.

There was also the old problem of screw versus Coffin spring. He found too many patients had difficulty with the screw and therefore the Coffin spring took that one problem away from the patient.

Under the indications for use, 1(*a*)—Class II cases where traction was required in the upper arch only—was a group of cases which was suggested as suitable for this type of therapy. He thought these cases were rather dangerous. The authors were referring to minimal overjets or a small amount of crowding with good lower arches. If the upper buccal segments were retracted by doing this, there was a tremendous tendency for the lower buccal segments to start moving forward, producing lower incisor imbrication.

This led to another factor. Very often, the buccal segments would be taken back and what looked like Class I premolar and molar occlusion achieved, but they were not quite far enough back, the patient having produced a forward displacement of the mandible into an apparent Class I position.

Therefore, he asked if the authors would agree that it was a good plan to take upper buccal segments too far back before letting them relapse into position.

With regard to 2(*a*)—Class I cases in which excessive mesial drift of buccal segments had occurred with production of anterior crowding—he did not think the anterior crowding was the result of mesial drift of the buccal segments. He thought the anterior crowding was there and the mesial drift resulted from the fact that there was no good contact between the labial segment and the buccal segment and, usually, in these cases, one had to take the buccal teeth an extremely long way back.

Again, for 2(*b*)—Class I cases in which excessive mesial drift of buccal segments had contributed to bimaxillary proclination—he wondered if it ever contributed to bimaxillary proclination. He would have thought bimaxillary proclination contributed to the mesial drift of the buccal segments. If the buccal teeth were forward because the incisors were proclined, the distal movement of the buccal segment would not result in the reduction of the bimaxillary characteristics.

Finally, he asked if the authors had any experience of extracting lower second molars and observing the eruption of the lower third molars.

Mr. W. J. Clark, replying, referred first to Mr. McCallin's point that it was controversial whether or not the upper teeth moved distally with extra-oral traction. There was evidence on both sides for this. In fact, some authorities, using the treatment Mr. McCallin suggested in the mixed dentition, had even gone so far as to suggest that the growth of the maxilla might be affected, that downward and backward movement of the ' A ' point could occur, and that the maxilla might even be rotating about a point in the base of the skull.

They had not shown any cases of early treatment in the mixed dentition. There was one case in fact that had been started in the mixed dentition—the one with the anterior crib. This was showing very good progress. In that particular case, no traction had been applied to the premolars at this stage and no evidence of the results of early treatment in the mixed dentition could be produced, because they had only been using this technique for a relatively short time. It had only been a period of four years since they had started using this appliance, although it now proved to have a wide application.

With regard to the large bite plate, it was because the tubes had to be accommodated that the bite plate had to be fairly thick. In fact, the bite plate was more or less level with the tips of the upper incisors, and usually it was sufficient to cut a groove in the bite plate where the lower incisors were biting, simply to prevent lingual collapse of the lower incisors.

Mr. McCallin was probably quite right in the point he made about expansion before distal traction: that expansion did not necessarily have to take place before distal traction was started but it was really a matter of convenience—not giving the patient too much to do at one time. Mr. McCallin preferred to use a Coffin spring as an alternative to a screw. He could not really make any comment because they always used screws.

With regard to distal traction in the upper arch only and the possibility of mandibular displacement and lower incisor imbrication resulting, this was something they had not come across.

The anterior crowding referred to was mainly forward and buccal displacement of the upper canines, and the distal movement was to accommodate them, or very mild imbrication of upper incisors with distal movement of the buccal segments to line them up.

With regard to bimaxillary proclination, he thought Mr. McCallin was right to point out that the mesial drift did not contribute to the bimaxillary proclination; it was the bimaxillary proclination that caused the mesial drift. He could not make any comment on lower third molars replacing lower second molars because he had never really seen this.

RESEARCH REPORTS

AN INVESTIGATION OF THE PHYSICAL AND PHYSIOLOGICAL ASPECTS OF SPEECH.*

By PETER VIG, B.D.S., F.D.S., D.ORTH. R.C.S.

PREVIOUS speech research has not revealed relationships between (1) orofacial morphology, (2) function, and (3) acoustic output for individual speakers.

The objectives of this study are (*a*) to establish a method for assessing these features, (*b*) to correlate them, in a ' normal ' sample, and (*c*) from a consideration of normal variations, produce a rational basis for the clinical evaluation of abnormalities.

Sample

23 adult males with normal speech and satisfactory occlusions were examined. Pre- and post-surgical records were also obtained from patients with mandibular deformities.

Material and Methods

1. *Morphological* data were obtained from cephalometric radiography, study models, and a clinical examination of soft-tissue morphology and behaviour.
2. *Function*: Speech movements were recorded by cineradiography (at 64 frames per second). Subjects commenced and finished each utterance in occlusion.
3. *Sounds*: O, SO, THO, EE, SEE, THEE, each sustained for a second, were recorded and are being analysed by sound spectrography.

(2) and (3) were repeated in most cases to check the reliability of method by the reproducibility of results.

Findings

From a preliminary analysis of cineradiographic and morphological data, the following observations have been made:—

1. A wide variety of articulatory patterns may be associated with normal speech.
2. However, each individual has a basic pattern which characterizes all his utterances.
3. Unlike previous reports, it appears that speech patterns are more intimately related to skeletal form than to the dental occlusion. Evidence suggests that where divergence between skeletal and dental types occurs, e.g., a Class I incisor relationship in the presence of all the typical Class II, division 2 characteristics, the patterns of muscular adaptation follow the skeletal type.

The combination of both size and shape of the intermaxillary space (and probably its relation to pharyngeal structures) seems the most consistent covariant of speech movement variations. With a high and long space the movements of the articulatory organs are minimal, whilst a short and shallow space is usually associated with maximal activity.

Conclusion

1. The method used seems adequate for an integrated and objective description of speech phenomena.
2. From the available evidence it seems that movements used for the articulation of speech are determined by:—

a. The acoustic target which is to be achieved, by shaping the vocal tract to produce the required resonant frequencies;

b. The rigid dental and skeletal confines within which the movable speech organs must adapt to shape the vocal tract;

c. The tendency to achieve this with the optimum physiological economy by structures whose primary function it is to maintain a continuous respiratory airway throughout life.

*This work is being carried out during the tenure of a Medical Research Council Clinical Research Fellowship.

THE DEVELOPMENT AND CLINICAL APPLICATION OF A NEW TECHNIQUE FOR MEASURING CHANGES IN THE ANGULATION OF THE INCISOR TEETH FOLLOWING APPLIANCE THERAPY.

By D. T. BENNETT and F. C. SMALES, Dental Hospital, Newcastle upon Tyne.

BY using specially designed apparatus, impressions aligned to the Frankfurt and mandibular planes were obtained. Casts of the impressions were made and in this manner study models orientated to the facial planes were obtained. Angulations of the incisor teeth to the facial planes were accurately measured by using an apparatus incorporating a vernier bevelled protractor.

This technique was found to have the following advantages over cephalometric analysis: (1) no radiation hazard, (2) easy location of individual incisors, (3) simplicity of clinical technique, and (4) it could be readily repeated. Extensive testing has shown that these measurements have an acceptable error, with a standard deviation of approximately 1·1°, i.e., 95 per cent of results fell within a range of 4·4°. These results are an improvement on similar measurements obtained from cephalometric analysis, where the error has been estimated as a standard deviation of approximately 2·2°, i.e., 95 per cent of results fell within a range of 8·8° (Bennett and Smales, 1965). Variations of a similar order have been reported in an earlier investigation (Broadway, Healy, and Poyton, 1962).

This method is at present being used to determine the changes which occur in the angulation of the incisor teeth when Class III malocclusions are treated by an intra-oral appliance, connected to an extra-oral chin cap by means of elastic bands. Preliminary results show that this therapy produces a rapid retroclination of the lower incisors and the re-establishment of a normal incisor relationship.

REFERENCES

BENNETT, D. T., and SMALES, F. C. (1965), Report to British Section of I.A.D.R.

BROADWAY, E. S., HEALY, M. J. R., and POYTON, H. G. (1962), *Dent. Practit.*, **12**, 455.

Presented at the Research Meeting held in Birmingham on 29 April, 1965.

DENTAL OCCLUSION IN THE EARLIEST MAMMALS. By J. R. E. MILLS, Institute of Dental Surgery, London, W.C.1.

THE morphological details of the dentitions of mammals have been widely studied, but the relationship of upper to lower teeth during chewing has in the past been neglected. Butler (1952), working on perissodactyls, and Mills (1955), on primates, have shown that it is possible to deduce the direction of jaw movement and relationship of the details of upper and lower teeth, from a study of the wear facets formed in function. In a further communication (Mills, 1965) I have applied the same principle to the Insectivora. From these studies it has become clear that the pattern of wear facets on the teeth of mammals is remarkably constant, although the exact position and relative sizes of these facets is affected by the nature of jaw movement during chewing.

The majority of fossil mammals are known only by their teeth and fragments of attached jaw. It is possible, by an examination of the wear facets on these teeth, and comparison with known recent genera, to deduce the shape of the opposing teeth and something of its jaw movement. Mammals are first known from the uppermost Triassic era, and for the first half of their history are known almost entirely from isolated fragments of bone carrying a few teeth. Using this technique I have shown (Mills, 1964) that the genera *Amphitherium* and *Peramus*, known only by their lower teeth, probably lay rather close to the main line of mammalian evolution. Kermack (1964) has applied the same technique to the new Cretaceous genus *Aegiolodon* from the Cretaceous. These studies have confirmed that the protocone was not the original upper molar cusp, and have shown its mode of evolution.

REFERENCES

BUTLER, P. M. (1952), *Proc. zool. Soc. Lond.*, **121,** 777.
KERMACK, K. A. (1964), unpublished communication to Linnean Society.
MILLS, J. R. E. (1955), *Dent. Practit.*, **6,** 47.
— — (1964), *Proc. Linn. Soc. Lond.*, **178,** 117.
— — (1965), *Ibid.*, in the press.

SOME APPLICATIONS OF ULTRASOUND IN THE EXAMINATION OF ORAL AND FACIAL TISSUES. By D. A. DIXON and J. R. PETTMAN.

FREQUENCIES above 16,000 cycles per second cannot be heard by the human ear and are known as ultrasonic. Frequencies of 1 to 5 million cycles per second are used in this investigation.

In the diasonoscope, a flaw detector manufactured by Portland Plastics, radio-frequency power is supplied to a transducer. The transducer transmits and receives. It contains a crystal which vibrates to emit an ultrasonic beam whose echoes are displayed by a cathode-ray oscilloscope.

Fluids and soft tissues of the body allow easy passage of the ultrasound, but bone, which absorbs it, does not. Tissue interfaces perpendicular to the ultrasonic beam throw back good echoes.

In this investigation of the possible applications of ultrasound to the dental regions, the following subjects have been considered:—

1. A study of the bony contour by measuring the thickness of soft-tissue cover.
2. The display of hard- and soft-tissue deficiencies of palate and deficiencies of palate and maxilla in cleft-palate patients.
3. Postoperative swelling.
4. Tongue morphology.
5. Muscular activity.
6. Pharyngeal width.

Method

Glycerin was used to coat the face of the transducer which was applied to the tissue surface.

Echoes were displayed on the screen as A-scope presentation. The echo readings were calibrated by comparison with direct measurement of tissue thickness.

THE PATTERN OF ALVEOLAR BONE RESORPTION FOLLOWING EXTRACTION OF ANTERIOR TEETH

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FAMILY resemblances in facial appearance are well known, and the classical example of the ' Hapsburg jaw ' illustrates clearly how hereditary factors can influence one part of the facial complex.

It has been traditional teaching that certain factors contributing to malocclusion of the teeth may be under genetic control, and recent investigations in this field have realized the need for precise measurements of various facial characteristics (Kraus, Wise, and Frei, 1959; Sarnas, 1959).

One feature of the face which promises well in family studies is the dental base relationship, because it can be easily measured on cephalometric radiographs as the difference between the angles SNA and SNB; furthermore, of the structures which are the immediate concern of the orthodontist, it might reasonably be expected to show the greatest evidence of hereditary control, certainly more so than the positions and relationships of the teeth which may be greatly influenced by environmental factors.

Unfortunately, in order to collect a sizeable sample for a family study, it may be necessary to include edentulous parents and to compare their dental base relationship with that of their children who have teeth. Although the SNA–SNB difference can be measured in the edentulous subject, such studies are open to the criticism that postextraction bone resorption or postextraction changes in the postural position of the mandible might have affected the relative positions of the A and B points and thus have led to fallacious results (Brown, 1963).

It is generally held that in the maxilla, postextraction resorption is more extensive on the labial side of the alveolar ridge than on the palatal side, whereas in the mandible, the greatest resorption is to be found along the bony lingual plate; so that the lower ridge becomes more prognathous than the upper. Thus it seemed possible that postextraction remodelling of bone might have an appreciable effect on the dental base relationship as measured by the SNA–SNB difference.

Table I.—MATERIAL USED IN THE INVESTIGATION

	No. of Cases	Age Range (years)	No. of Maxillary Anterior Teeth extracted		No. of Mandibular Anterior Teeth extracted	
			Mean	Range	Mean	Range
Males	12	23–56	5·3	4–6	5·8	5–6
Females	10	29–61	5·7	4–6	5·8	4–6

Coccaro and Lloyd (1962) have shown that the A and B points may be affected by postextraction resorption, but the attendant changes in SNA–SNB difference were not reported. In an attempt to amplify these findings, it was decided to make a longitudinal cephalometric study of patients who were to have upper and lower anterior teeth extracted.

More precisely, the objectives were threefold:—

1. To compare the SNA–SNB difference before and after extractions. Any changes, which may be called the overall changes, might result from an alteration in the postural position of the mandible, or postextraction bone resorption involving the A and B points, or a combination of both.

2. To find out what part of the overall change in SNA–SNB difference can be attributed to bone resorption affecting the A and B points.

Presented at the Research Meeting of held in Birmingham on 29 April, 1965.

3. To check the prosthetic textbook picture of alveolar resorption by comparing the amounts of bone lost on the labial and on the lingual sides of the alveolar ridges following extractions.

MATERIAL

The clinical material consisted of 22 patients who had dental clearances which included simple extraction of upper and lower anterior teeth. Details of the material are given in *Table I*.

METHOD

Each patient had 90° lateral cephalometric X-rays taken before extractions, within 1 week after extractions, and 3–4 months later before dentures were inserted. The first film was taken with the teeth in occlusion and the second and third films were taken with the mandible in the rest position, or as close to the rest position as we could achieve, using the ' no command ' technique recommended by Coulombe (1954).

Tracing Procedure

A sheet of plastic tracing material was arranged over the pre-extraction film and the outline of the incisor teeth and the related alveolar processes, together with the lower and posterior borders of the mandible, and various structures in the upper face and skull base were drawn in. This tracing was then superimposed on the final film with the upper face and skull base in register and the outline of the maxillary alveolar bone on the final film was added to the tracing. Then, with the tracing superimposed on the lower and posterior borders of the mandible, the final alveolar outline in the mandible was also added (*Fig*. 1). By superimposing maxilla on maxilla, and mandible on mandible in this way, it was possible to eliminate changes in dental base relationship arising from changes in mandibular posture. The SNA–SNB difference before and after extractions was measured on photocopies of this tracing

Fig. 1.—Composite tracing showing alveolar outlines before extractions (continuous line) and 3 months after extractions (interrupted line) for calculation of the resorption change in SNA–SNB difference.

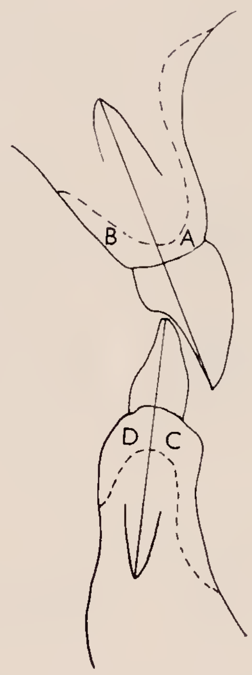

Fig. 2.—Composite tracing enlarged for planimeter measurements. Area A was compared with area B, and area C with area D.

Fig. 3.—Composite tracing with outline of mandibular symphysis added for calculation of the overall change in SNA–SNB difference.

and the change in SNA–SNB difference due to resorption was calculated.

The composite tracing was then placed in an enlarger set to produce a magnification of $\times 3$, and the outline of the central incisor teeth and the alveolar processes was copied on a sheet of paper on the base board. The long axes of the teeth were marked on the drawing, and these long axes were taken as the arbitrary dividing lines between the labial and lingual parts of the alveolar processes (*Fig*. 2). The areas representing bone loss on the labial and on the lingual sides of the alveolar ridges were measured on this drawing using a planimeter on its most sensitive setting.

Returning to the final X-ray film, the composite tracing was again superimposed on the skull base and upper face, and the outline of the mandibular symphysis on the final film was traced (*Fig*. 3). Photocopies of this tracing were prepared, and on these the final angle SNB was measured and the overall change in SNA–SNB difference was worked out.

As a check on the errors in measurement, the whole process of tracing, photocopying, and measuring was repeated for double determinations.

RESULTS

There were available two sets of 22 measurements of the overall change in SNA–SNB difference, and two sets of 22 measurements of the change in SNA–SNB difference due to resorption. These double determinations were tested statistically using the method described by Dahlberg (1948). The standard deviation of a single determination of the overall change in SNA–SNB difference was 0·37°, and of the change due to resorption, 0·31°. Thus it appeared that the errors of measurement were within acceptable limits. For subsequent calculations, only the first set of measurements was used.

On examining the 22 tracings it was apparent that bone resorption had extended to the A point in 13 cases and to the B point in 19 cases. The average change in SNA was 0·74° and in SNB, 0·57°.

Details of the overall and resorption changes in SNA–SNB difference are given in *Table II.*

The mean overall change in SNA–SNB difference was −2·21° and was significant at the 0·1 per cent level. The mean change in SNA–SNB difference due to resorption amounted to only −0·13° and was not significant.

The results of the planimeter measurements are shown in *Table III.* Both in the maxilla and in the mandible, there was significantly greater bone loss on the labial side of the alveolar ridge than on the lingual side following extraction of the anterior teeth.

Table II.—Changes in SNA–SNB Difference

	Mean* (degrees)	Standard Error (degrees)	t	Level of Significance
Change in SNA–SNB (overall)	−2·21	0·38	5·88†	P <0·001
Change in SNA–SNB due to resorption	−0·13	0·19	0·65	P >0·10

* Negative sign indicates a tendency to mandibular prognathism.
† Denotes significance.

Table III.—Comparison of Bone Loss on Labial and Lingual Sides of Alveolar Ridges

	Mean Difference between Bone Loss on Labial and Lingual Sides of Alveolar Ridge	Standard Error	t	Level of Significance
Maxilla	202·77	45·69	4·44*	P <0·001
Mandible	240·09	43·72	5·49*	P <0·001

* Denotes significance.

DISCUSSION

The patients used in this investigation were the first 22 for whom it was possible to prepare full records. All of them had been referred for dental clearances because of expected difficulties in extraction or anaesthesia. Some had valvular heart disease, many had periodontal disease. Although material of this kind may not be regarded as a random sample of the population, it sufficed to show the general nature of the changes in the jaws and jaw relationships resulting from tooth extraction.

Great care was exercised in removing the teeth in order to keep the bone loss at the time of extraction to a minimum. Comparison of the films taken before and those taken immediately after extractions, indicated that this aim had been achieved in most cases, so that the major part of the alteration in alveolar contour could justifiably be ascribed to bone resorption following the removal of teeth.

The ‘ no command ’ technique described by Coulombe (1954) involves engaging the subject in informal conversation while seating him in the chair and inserting the earposts, then exposing the film during a pause in the conversation. Coulombe, in edentulous patients, found that the position of the mandible determined using this technique did not differ significantly from that produced by asking the patient to perform various phonetic exercises commonly used by the prosthetist in finding the ‘ rest position of the

mandible '. The results of the present investigation indicate that, in the hands of the author, the ' no command ' technique is an insufficiently precise way of reproducing the jaw relationship which existed before the teeth were extracted.

Although postextraction bone resorption was found to affect the A and B points, the resulting change in dental base relationship was of very small magnitude, and seemed unlikely to give rise to spurious results in a family study. On the other hand, the overall changes in dental base relationship were statistically significant. These findings taken together, suggest that it would be valid to include edentulous parents in a family study, providing a satisfactory technique for finding the endogenous postural position of the mandible was used.

The overall increase in relative mandibular prognathism, in conjunction with the insignificant effects of bone resorption, indicated that the patients were either protruding the mandible for the final film or that they were in a position of overclosure. By superimposing the composite tracing on the final photocopy and by rotating the tracing round the head of the condyle, it was possible to determine whether overclosure or protrusion was the more dominant feature. It was found that protrusion predominated in only 5 cases.

The planimeter finds its chief use in civil engineering, where it is necessary to work out the area of a piece of land from maps or from drawings.

Although no formal statistical check of the planimeter measurements was made in this investigation, the values used in each case were the means of several readings. Those experienced in the use of this instrument estimate the error of measurement in the region of 2 per cent.

The findings reported here leave no doubt that more bone is lost on the labial side of both maxillary and mandibular alveolar ridges following extractions.

CONCLUSIONS

1. The dental base relationship measured by the SNA–SNB difference in the edentulous subject 3–4 months after extractions may show significant overall changes from that measured in the same subject before the loss of teeth, when the ' no command ' technique for finding the rest position of the mandible is used.
2. Most of this change can be attributed to a change in mandibular posture, the changes in SNA–SNB difference due to postextraction bone resorption being of little consequence.
3. Postextraction alveolar resorption would not invalidate studies of dental base relationship in families which include edentulous parents. More serious discrepancies might arise through failure to reproduce the mandibular position which existed before the teeth were extracted.
4. In both maxilla and mandible, more bone is lost on the labial side of the alveolar ridge than on the lingual side up to 4 months after extraction of anterior teeth, taking the long axes of the central incisors as the dividing line between labial and lingual.

Acknowledgements

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REFERENCES

Brown, W. A. B. (1963), *Trans. europ. orthod. Soc.*, 105.

Coccaro, P. J., and Lloyd, R. S. (1962), *Amer. J. Orthodont.*, **48**, 625.

Coulombe, J. A. R. (1954), *J. Canad. dent. Ass.*, **20**, 536.

Dahlberg, G. (1948), *Statistical Methods for Medical and Biological Students*, p. 126. London: George Allen & Unwin Ltd.

Kraus, B. S., Wise, W. J., and Frei, R. H. (1959), *Amer. J. Orthodont.*, **45**, 172.

Sarnas, K. V. (1959), *Odont. Revy*, **10**, suppl. 4.

THE RELATIONSHIP BETWEEN THE RELATIVE AMOUNT OF SPACE PRESENT IN THE DECIDUOUS DENTAL ARCH AND THE RATE AND DEGREE OF SPACE CLOSURE SUBSEQUENT TO THE EXTRACTION OF A DECIDUOUS MOLAR

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Loss of deciduous molars before their normal shedding time is followed, in some children, by rapid and complete closure of the space, while in others there is little or no space loss. This difference in reaction to premature extraction of deciduous teeth has been explained in several ways.

Seipel (1946, 1949), in a cross-sectional study of 1500 individuals in each of three age-groups (4, 13, and 21 years), found that there was a tendency towards greater space loss in crowded dentitions than in those which were spaced.

Lundström (1955), in a review of his own work and that of other writers, observed that the '... relative arch spacing is the most important cause of differences in reaction to premature extraction'.

Clinch (1959), in a group of 29 children, correlated the spacing in the deciduous dental arch at 3–4 years with the space loss 11 years later at 13–14 years and found significant correlations between these two factors.

The age at the time of extraction is another factor which may account for variability of response to early loss. Turner (1931, 1934), Lundström (1955), Seipel (1949) and Clinch (1959) agreed that the earlier an extraction was carried out, the more space would be lost. Miller (1962) crystallized the opinions expressed by Hunter (1778), Hutchinson (1884), and more recently by Logan (1960), by describing 'critical ages' for loss of certain teeth. The stage when a particular tooth was erupting was considered to be a 'critical age' for extraction of the tooth immediately anterior to it, since erupting teeth drift forward more rapidly than those which are already in occlusion. For example, 5–6 years when the first permanent molar is erupting was held to be a 'critical age' for extraction of a second deciduous molar.

The occlusion, or lack of occlusal contact, is another factor influencing space closure. This has been mentioned by Davenport (1887), Bogue (1889), Dewey and Anderson (1942), Seipel (1949), Brauer and others (1953), and Lundström (1955).

Space closure following early loss also varies according to the particular tooth which is extracted. Schachter (1943), Ungar (1938), Seipel (1946, 1947), Breakspear (1951), and Clinch (1959) found that more space was lost after extraction of second deciduous molars than first deciduous molars, and that there was a more rapid and relatively greater space loss in the upper jaw than in the lower.

The rate of space loss subsequent to extraction of teeth has been discussed by a number of writers.

Salzmann (1938), from his findings in a group of 500 children, aged between 15 and 19 years, who had lost one or more first permanent molars, noted that the rate of space loss was variable and was affected by 'habit, environment, and other conditions'. He found that spaces closed more quickly in the upper arch than in the lower arch.

Seipel (1946) observed that there was a slow steady migration of teeth in the deciduous dentition after early loss, while in the permanent dentition there was a rapid initial loss of space and the rate of loss thereafter decreased.

Breakspear (1951) reviewed 100 cases who had unilateral premature extraction of first or second deciduous molars, and noted that there was a regular rate of space loss which slowed down after the second year.

If, as has been suggested, the relative arch spacing is the most important factor in determining the amount of space which will be lost subsequent to extraction of a tooth, it might be possible to predict, from measurement of the space condition, the amount of space which will be lost if a particular tooth is extracted.

In an attempt to elucidate this question the following investigation was undertaken.

MATERIAL

The material used for this study consisted of a group of 74 children, 30 girls and 44 boys, who formed part of a larger group of 300 enrolled in a longitudinal growth study project (Adams, 1963). All the children were aged between 5 and 6 years and had intact deciduous dentitions at the commencement of the growth study. They have been examined and various data have been

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recorded by means of models, cephalometric radiographs, photographs, and notes, at 6-monthly intervals for a period of $2\frac{1}{2}$ years up to the time of writing. The present group of 74 were selected because all of them had lost one or more deciduous molars since the first recordings were made.

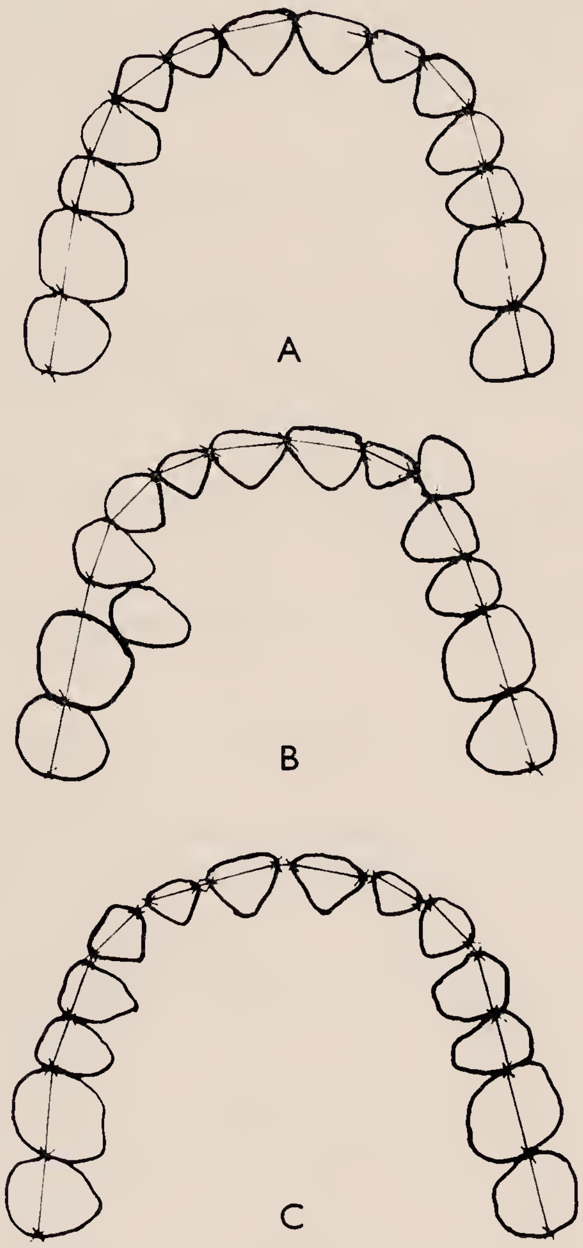

Fig. 1.—Measurement of the arch length in, A, a well-aligned arch; B, a crowded arch; C, a spaced arch.

MEASUREMENTS

Measurements were made on plaster models using a Baker vernier microscope. These measurements were made by one observer only, because it has been shown in a previous study that, while one observer can reproduce his measurements with a fair degree of accuracy, variation between observers may be considerable (Richardson, Adams, and McCartney 1963). Consequently all measurements were made twice by the same observer and if the difference exceeded 0·2 mm., the minimum significant difference detected between two measurements by a single observer reported by Richardson and others, the measurement was checked. In practice it was found that very few measurements had to be checked and almost invariably the fault lay either in misreading the scale or in misplacing the model. An average of the two measurements was used for subsequent calculations.

Total Tooth Size

This was taken to be the sum of the widest mesiodistal diameters of the 10 deciduous teeth.

Arch Length

In a well-aligned arch with all the teeth in contact, it was considered that the arch length would be equal to the total tooth size. Where spaces occurred, they were measured separately and added to the total tooth size to find the arch length. In cases which had crowded or rotated teeth, the distance in the arch between the two adjoining teeth was measured and substituted for the size of the tooth in question in the calculation of the arch length (*Fig.* 1).

Space Condition

This was expressed as:—

Arch length minus total tooth size,

so that positive values represent spaced dentitions, negative values crowded dentitions, and zero values well-aligned arches with contact all round.

Space Loss

The size of each extracted tooth was measured from the first set of models. The size of each space remaining was measured on the models taken at subsequent 6-monthly periods and the difference between the original tooth size and the remaining space relating to it gave the amount of space lost at the end of each 6-monthly period.

STATISTICAL ANALYSIS

The data were extremely heterogeneous as regards the type and number of teeth extracted and the timing of extractions. This made statistical analysis difficult. It was decided, therefore, to select those cases from which only one deciduous molar had been extracted from either arch. These numbered 51 in all, and yielded 19 upper arches and 37 lower arches suitable for investigation. The data available for these arches were as follows: a figure denoting the space condition present in the intact arch and figures denoting the amount of space lost at the end of the first, second, third, and fourth 6-monthly periods after the extraction. In the third and fourth periods some of these cases were complicated by further extractions, so that the number of arches which fulfilled the requirement of losing only one deciduous molar was reduced to 26 in the third period and 13 in the fourth period.

1. Correlation coefficients were calculated between the space condition and space loss at the end of the first, second, third, and fourth

6-monthly periods after extraction of one deciduous molar, and between the space loss at the end of the first and second 6-monthly periods, the first and third 6-monthly periods, and the first and fourth 6-monthly periods.

2. The mean differences in the amounts of space lost at the beginning and end of the first, second, third, and fourth 6-monthly periods were calculated, and tested for significance using Student's t test.

Table I.—Correlation Coefficients between Space Condition and Space Loss at the End of First, Second, Third, and Fourth 6-monthly Periods

Correlation	r	Probability	No. of Cases
r_{xy_1}	−0·36*	0·001–0·01	56
r_{xy_2}	−0·39*	0·001–0·01	56
r_{xy_3}	−0·47*	0·02 –0·05	26
r_{xy_4}	−0·66*	0·01 –0·02	13

* Denotes significance.

x = space condition; y_1 = space loss at the end of first 6 months; y_2 = space loss at the end of second 6 months; y_3 = space loss at the end of third 6 months; y_4 = space loss at the end of fourth 6 months

3. In a group of 23 children, who had lost lower first deciduous molars, correlation coefficients were calculated between the space condition and space loss at the end of the first 6 months for 10 of these, who had extractions before the first permanent molars erupted, and for the remaining 13, who had extractions after the first permanent molars erupted.

4. Regression coefficients were calculated for space loss at the end of the second, third, and fourth 6-monthly periods on that at the end of the first.

5. The mean space condition and the mean amounts of space lost at the end of the first and second 6-monthly periods were calculated for (*a*) a group of 37 who had lost one lower deciduous molar, (*b*) a group of 19 who had lost one upper deciduous molar, (*c*) a group of 23 who had lost one lower first deciduous molar, and (*d*) a group of 14 who had lost one lower second deciduous molar.

The differences between space loss after extraction of an upper deciduous molar compared with the space loss after extraction of a lower deciduous molar, and between the space loss after extraction of a lower first deciduous molar and the space loss after extraction of a lower second deciduous molar were tested for significance using Student's t test.

RESULTS AND DISCUSSION

1. There were significant negative correlations between the space condition in the dental arch and the amount of space lost at the end of the first, second, third, and fourth 6-monthly periods subsequent to the extraction of one deciduous molar (*Table I*). This indicated that the space condition had some influence on the amount of space lost subsequent to an extraction; that is to say the space loss in crowded cases tended to be greater than in dentitions which were spaced at the first examination. However, the correlation coefficients were low, −0·36, −0·39, −0·47, and −0·66 respectively, indicating that space loss is not entirely dependent on the space condition and that there must be other factors which play a part in determining the amount of space lost in the first 2 years after extraction of a deciduous molar.

Clinch (1959), correlating the space condition in the deciduous arch and space loss in the permanent arch 11 years later, found coefficients of a similar order of magnitude to these but she also found a significant positive correlation in the lower arch and a significant negative correlation in the upper arch (+0·44, −0·44, n = 23).

Table II.—Correlation Coefficients between Space Loss at End of First and subsequent 6-monthly Periods

Correlation	r	Probability	No. of Cases
$r_{y_1y_2}$	0·84*	<0·001	56
$r_{y_1y_3}$	0·86*	<0·001	26
$r_{y_1y_4}$	0·75*	<0·01	13

* Denotes significance.

y_1 = space loss at the end of the first 6 months; y_2 = space loss at the end of the second 6 months; y_3 = space loss at the end of the third 6 months; y_4 = space loss at the end of the fourth 6 months.

2. In the present study, high significant positive correlations were found between the amount of space lost at the end of the first and subsequent 6-monthly periods, 0·84, 0·86, and 0·75 respectively (*Table II*). This indicated that if a dentition had a high space loss at the end of the first 6 months, it tended to have a high space loss at the end of subsequent 6-monthly periods, and conversely if the space loss was low at the end of the first 6 months it tended to be low in later periods.

3. The mean differences in the amounts of space lost during the first, second, third, and

fourth 6-monthly periods were examined (*Table III*), and it was noted that the largest mean difference occurred in the first 6 months and the rate of loss thereafter was less. All mean differences differed significantly from zero.

Seipel (1946) found a similar pattern for the rate of space loss in the permanent dentition but in the deciduous dentition he found that there was a slow steady rate of space loss.

4. The original group of 56 was divided into those who had lost upper or lower molars, and the group that had lower molars extracted was further subdivided into those who had lost lower first or lower second deciduous molars; correlation coefficients were calculated between the space condition and the space loss at the end of the first and second 6-monthly periods for these groups. The significant correlations were similar to those found for the group as a whole and are shown in *Table IV*.

5. In an attempt to isolate other factors which may influence the amount of space lost, the data were examined further. It was noted that in some cases the teeth were extracted before eruption of the first permanent molars and in others after eruption of these teeth. In the group of 23 children who had lost lower first deciduous molars, 10 lost the teeth before eruption of the first permanent molars and 13 after. A significant negative correlation (−0·79) was found between the space condition and space loss in the first 6 months for the group who had extractions before eruption of the first permanent molars, but no evidence of correlation (correlation coefficient −0·09) in the group who had extractions after eruption of the first permanent molars (*Table V*).

Although the numbers in the groups were small, these findings suggested the hypothesis that the space condition had more influence on the amount of space lost subsequent to an extraction, if this extraction were carried out before eruption of the first permanent molars, than after the eruption of these teeth. To test this hypothesis it would have been desirable to follow up the group who had their teeth extracted before eruption of the first permanent molars to establish whether the correlation coefficient between the space condition and space loss changed after eruption of the first permanent molars. Unfortunately the group was too small for further subdivision in this way and no additional data were available.

Table III.—Mean Differences between Space Loss at the Beginning and End of Each 6-monthly Period after extraction of One Deciduous Molar

Difference	Mean Difference (mm.)	Standard Error (mm.)	95 per cent Confidence Limits (mm.)	t	Probability	No. of Cases
$0-y_1$	1·37	0·15	−0·83 to 3·57	9·13	<0·001	56
y_2-y_1	0·86	0·09	−0·48 to 2·20	9·5	<0·001	56
y_3-y_2	0·77	0·08	−0·01 to 1·55	9·25	<0·001	26
y_4-y_3	0·59	0·13	−0·37 to 1·55	4·5	<0·001	13

y_1 space loss at end of first 6 months; y_2 space loss at end of second 6 months; y_3 space loss at end of third 6 months; y_4 space loss at end of fourth 6 months.

However, there is some indication that eruption of the first permanent molar may have some influence on the space loss after extraction or may in some way control the effects of the space condition on space loss. It is generally accepted that the earlier extractions occur the more space will be lost and the influence of the first permanent molar eruption may, in part, explain why this should be so.

6. *Figs*. 2–4 show the regression lines between the amount of space loss at the end of the first and subsequent 6-monthly periods. The average amount of space which will be lost at the end of the second, third, and fourth 6-monthly periods could be estimated from the amount lost in the first 6 months fairly reliably by use of these regression lines, because of the high correlation coefficients involved. If these calculations can be extended as further observations are made, it should be possible, eventually, to predict the final average amount of space which will be lost for any given measurement of the amount of space lost at the end of the first 6 months.

7. Comparisons of the mean space condition and the mean amounts of space lost at the end of the first and second 6-monthly periods were made between a group of 19 who had lost one upper deciduous molar and a group of 37 who had lost one lower deciduous molar, using the t test, and the results are shown in *Table VI*. Comparison of the mean space conditions of these two groups showed that there was slightly more

spacing in the upper arch group than in the lower, but the difference was not significant (t = 1·48), and it was considered that they were as comparable in terms of space condition as it was possible to achieve. It was therefore considered in the group who had an upper deciduous molar extracted than in the group who had a lower deciduous molar extracted, but the differences were not significant (t = 0·46 and 0·54 respectively).

Table IV.—CORRELATION COEFFICIENTS BETWEEN SPACE CONDITION AND SPACE LOSS AT THE END OF THE FIRST AND SECOND 6-MONTHLY PERIODS, AND BETWEEN SPACE LOSS AT THE END OF THE FIRST AND SPACE LOSS AT THE END OF THE SECOND 6-MONTHLY PERIODS, WHEN THE ORIGINAL 56 ARE DIVIDED INTO SUBGROUPS

GROUP	CORRELATION	r	PROBABILITY	NO. OF CASES
One upper deciduous	$^{r}xy_1$	−0·56*	0·01–0·02	19
molar extracted	$^{r}xy_2$	−0·50*	0·02–0·05	19
	$^{r}y_1y_2$	0·88	< 0·001	19
One lower deciduous	xy_1	−0·21	> 0·10	37
molar extracted	$^{r}xy_2$	−0·35*	0·02–0·05	37
	$^{r}y_1y_2$	0·77*	< 0·001	37
One lower first	$^{r}xy_1$	−0·35	0·05–0·10	23
deciduous molar	$^{r}xy_2$	−0·44*	0·02–0·05	23
extracted	$^{r}y_1y_2$	0·90*	< 0·001	23
One lower second	$^{r}xy_1$	−0·18	> 0·10	14
deciduous molar	$^{r}xy_2$	−0·37	> 0·10	14
extracted	$^{r}y_1y_2$	0·55*	0·02–0·05	14

* Denotes significance.
x = space condition; y_1 = space loss at end of first 6 months; y_2 = space loss at end of second 6 months.

Table V.—CORRELATION COEFFICIENTS BETWEEN THE SPACE CONDITION AND SPACE LOSS AT THE END OF FIRST 6 MONTHS IN CASES WHO HAD LOST ONE LOWER DECIDUOUS MOLAR BEFORE AND AFTER ERUPTION OF FIRST PERMANENT MOLARS

	CORRELATION	r	PROBABILITY	NO. OF CASES
Before eruption of first permanent molars	$^{r}xy_1$	−0·79*	0·001–0·01	10
After eruption of first permanent molars	$^{r}xy_1$	−0·09	> 0·10	13

* Denotes significance.
x = space condition; y_1 = space loss at the end of first 6 months.

legitimate to compare the space loss after extraction of an upper deciduous molar and the space loss after extraction of a lower deciduous molar in these groups. Slightly more space was lost at the end of the first and second 6-monthly periods

If formal tests of significance are ignored, it is interesting to note that, although the upper arch group had more spacing than the lower arch group, more space was lost after extraction of an upper deciduous molar than a lower, indicating

that the difference in space loss cannot be attributed to the difference in space condition in the two groups.

8. The group who had a lower deciduous molar extracted was subdivided into those who had lost

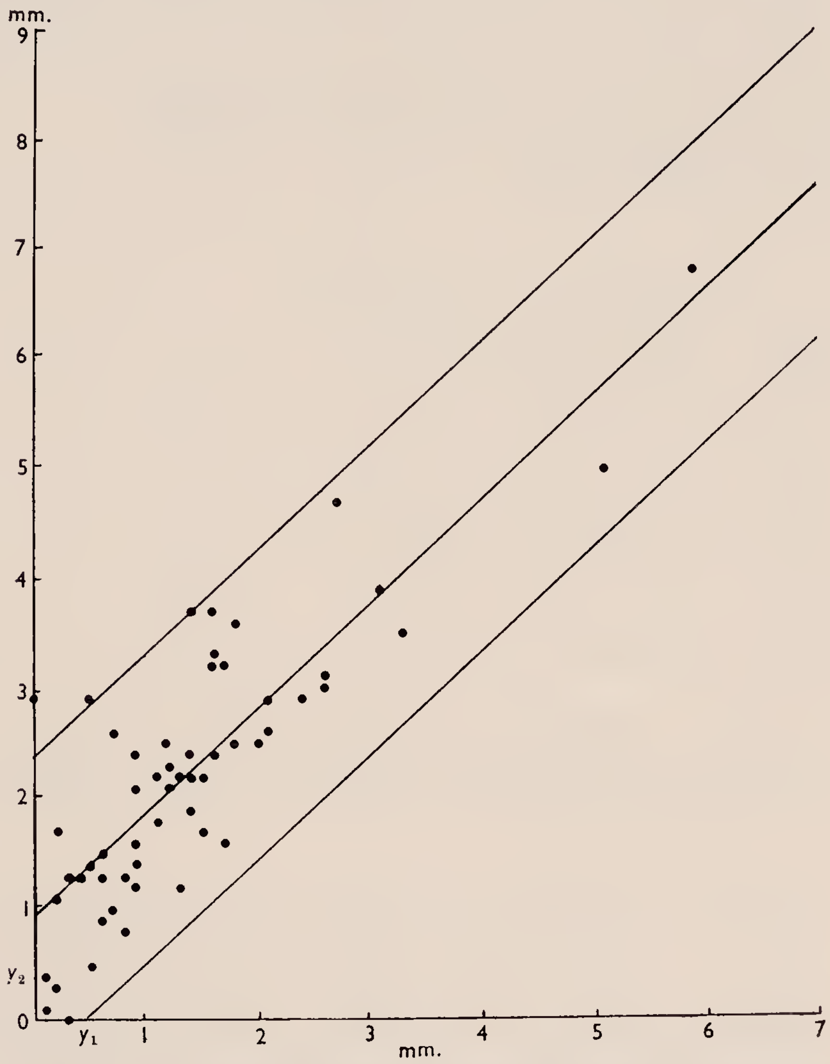

Fig. 2.—Regression of space loss at the end of the second 6 months (y_2) on the space loss at the end of the first 6 months (y_1).

$y_2 = 0{\cdot}92 + 0{\cdot}94\ y_1$; S.D. from regression 0·67 mm.; S.E. of regression coefficient 0·15 mm.; $n = 56$.

Table VI.—Comparison of Means between (i) a Group who had lost One Lower Deciduous Molar ($n = 37$) and (ii) a Group who had lost One Upper Deciduous Molar ($n = 19$)

	(i) (mm.)	(ii) (mm.)	Difference (mm.)	t	Probability
$\bar{x}$	1·76	2·89	1·13	1·48	0·10–0·20
$\bar{y}_1$	1·32	1·46	0·14	0·46	0·60–0·70
$\bar{y}_2$	2·14	2·33	0·19	0·54	0·50–0·60

$\bar{x}$ = mean space condition; $\bar{y}_1$ = mean space loss at the end of first 6 months; $\bar{y}_2$ = mean space loss at the end of second 6 months.

a lower first deciduous molar (23) and those who had lost a lower second deciduous molar (14). The average space condition in the lower second deciduous molar group was slightly higher than in the lower first deciduous molar group, that is, the second deciduous molar group had more spacing than the first but the difference was not significant ($t = 1{\cdot}53$), and it was considered legitimate to compare the space loss in the two groups.

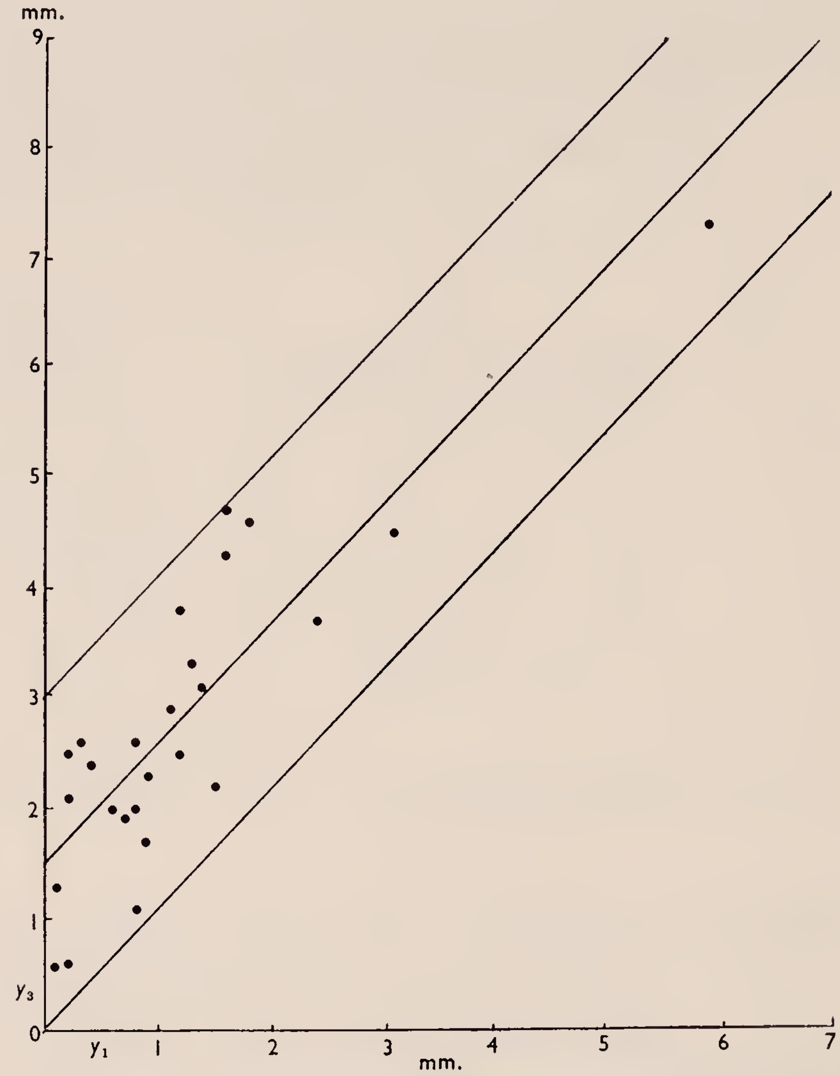

Fig. 3.—Regression of space loss at the end of the third 6 months (y_3) on the space loss at the end of the first 6 months (y_1).

$y_3 = 1{\cdot}52 + 1{\cdot}07\ y_1$; S.D. from regression 0·74 mm.; S.E. of regression coefficient 0·25 mm.; $n = 26$.

Table VII.—Comparison of Means between (i) a Group who had lost a Lower First Deciduous Molar ($n = 23$) and (ii) a Group who had lost a Lower Second Deciduous Molar ($n = 14$)

	(i) (mm.)	(ii) (mm.)	Difference (mm.)	t	Probability
$\bar{x}$	1·24	2·60	1·36	1·53	0·10–0·20
$\bar{y}_1$	1·17	1·55	0·38	1·42	0·10–0·20
$\bar{y}_2$	2·00	2·38	0·38	1·19	0·20–0·30

$\bar{x}$ = mean space condition; $\bar{y}_1$ = mean space loss at the end of first six months; $\bar{y}_2$ = mean space loss at the end of second 6 months.

Slightly more space was lost at the end of the first and second 6 months in the group who had a lower second deciduous molar extracted, but the differences were not significant ($t = 1{\cdot}42$ and 1·19 respectively) (*Table VII*). Again, ignoring

tests of significance, it is interesting to note that the group with more original spacing, the lower second deciduous molar group, had most space loss after extraction of a tooth.

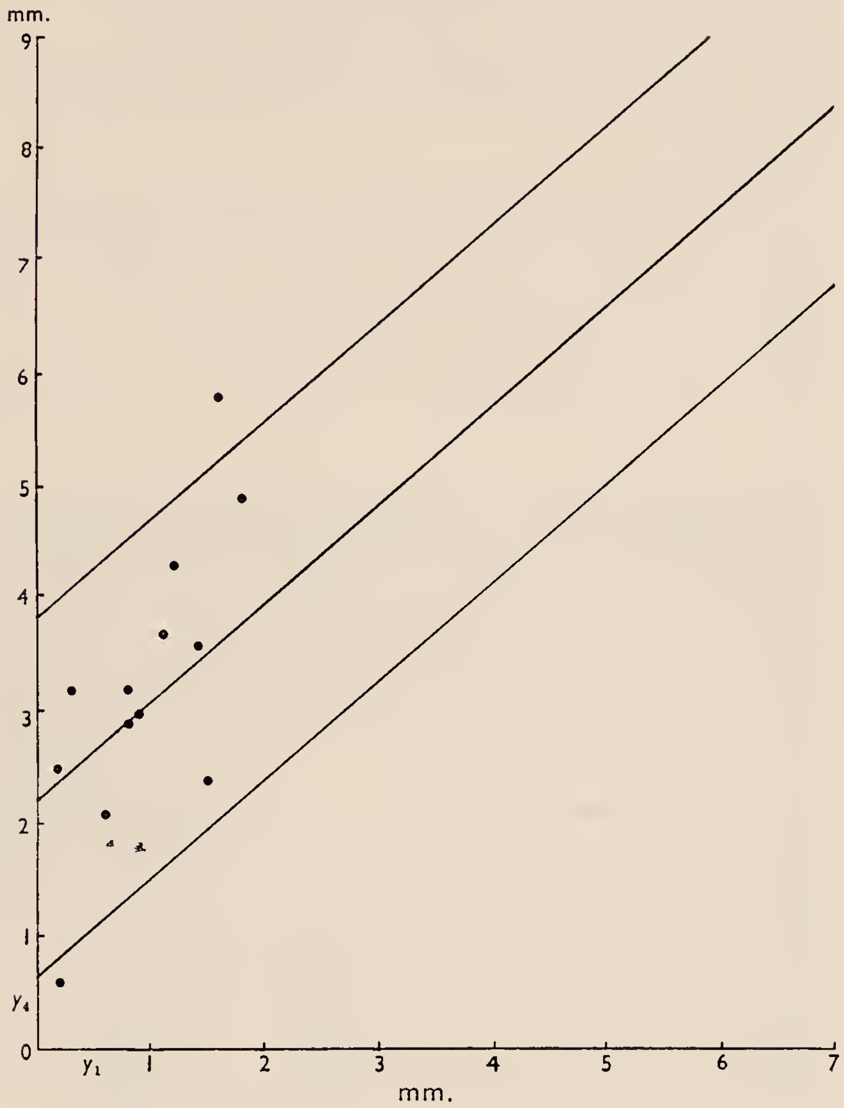

Fig. 4.—Regression of space loss at the end of the fourth 6 months (y_4) on the space loss at the end of the first 6 months (y_1).
$y_4 = 1{\cdot}55 + 1{\cdot}52\ y_1$; S.D. from regression 0·90 mm.; S.E. of regression coefficient 0·70 mm.; $n = 13$.

Clearly more data are required before firm conclusions can be drawn from an analysis such as in *Tables VI* and *VII*, because important tendencies are suggested which may be too small to detect as significant with the data at present available. Ideally the comparison of space closure, following the extraction of an upper as against a lower deciduous molar and a lower first as against a lower second deciduous molar, should be made in the same individual and since the findings in the present study are based on data from different children they cannot be regarded as conclusive.

Seipel (1946), Clinch (1959), and Breakspear (1951), among others, found that there was a greater space loss in the upper arch than in the lower after loss of a deciduous molar and a greater loss of space after extraction of a lower second as against a lower first deciduous molar. The findings of these writers were all based on data from different individuals. In the cases of Seipel and Breakspear the studies were cross-sectional and neither took into consideration the effect of the space condition. However, their figures are based on measurements made up to 5 years after the extractions took place and Clinch's measurements extended over a period of 11 years, while the figures given in this section of the present study only cover the first year after extraction.

The present findings agree with these writers in that there was slightly more space lost after extraction of an upper deciduous molar than a lower and more space lost after extraction of a lower second than a lower first deciduous molar at the end of the first and second 6 months after the extraction. Although the differences found in this study were consistent with those of other workers, they were not significant, so that the conclusions must remain tentative.

SUMMARY OF RESULTS

1. Significant negative correlations were found between the space condition and space loss in the first 2 years after extraction of a deciduous molar. That is to say, crowded dentitions tended to lose more space after an extraction than spaced dentitions. The values of these coefficients were low, indicating that other factors must also influence space loss.
2. High positive correlations were found between space loss at the end of the first and subsequent 6-monthly periods.
3. Regression lines between the space loss at the end of the first and subsequent 6-monthly periods made it possible to predict the average space loss at the end of the second, third, and fourth 6-monthly periods from the space loss in the first 6 months.
4. On the average, the largest amount of space was lost in the first 6 months and the rate of loss thereafter was less.
5. High negative correlations were found between the space condition and space loss in the first 6 months before eruption of the first permanent molars, but not after. This suggested that eruption of the first permanent molars may have some influence, direct or indirect, on space loss.
6. Slightly more space was lost when an upper deciduous molar was extracted than when a lower deciduous molar was extracted, and slightly more space was lost when a lower second deciduous molar was extracted than when a lower first deciduous molar was extracted. Although these differences were not significant and the measurements were made on different individuals, the results showed a similar pattern to those of other investigators.

CONCLUSIONS

1. It is obvious from this investigation that it is not possible, by measuring the space condition in

the deciduous arch, to predict from this measurement the amount of space which will be lost if a deciduous molar is extracted.

2. It is apparent, however, that there is a tendency for more space to be lost if the deciduous dentition is crowded than if it is spaced.

3. Observation of the extraction space during the first 6 months after the tooth is removed will give a good indication of the final amount of space closure.

4. Relative arch spacing may be the most important factor in the reaction to premature extraction, but many other variable factors, including the age and site of extraction, complicate the result and no mathematical formulae can be used to calculate the total amount of space which will be lost after extraction of a tooth.

Acknowledgements

I am very grateful to Mr. C. P. Adams for permission to use material from the Belfast Growth Study; to Professor E. C. Cheeseman for advice on the Statistics; and to my husband for preparation of the illustrations and for his advice.

REFERENCES

Adams, C. P. (1963), *Trans. europ. orthod. Soc.*, 265.
Bogue, E. A. (1889), *Dent. Cosmos*, **31,** 581.
Brauer, J. C., Demeritt, W. W., Higley, L. B., Lindahl, R. L., Massler, M., and Schour, I. (1953), *Dentistry for Children.* New York: The Blakiston Co.
Breakspear, E. K. (1951), *Dent. Rec.*, **71,** 127.
Clinch, L. M. (1959), *Dent. Practit.*, **9,** 109.
Davenport, I. B. (1887), *Dent. Cosmos*, **29,** 413.
Dewey, M., and Anderson, G. M. (1942), *Practical Orthodontics*, 6th ed., p. 128. London: Henry Kimpton.
Hunter, J. (1778), *A Practical Treatise on the Diseases of the Teeth; intended as a Supplement to the Natural History of those Parts.* London: J. Johnston.
Hutchinson, S. J. (1884), *Brit. dent. J.*, **5,** 75.
Logan, W. R. (1960), *Ibid.*, **109,** 437.
Lundström, Anders (1955), *Amer. J. Orthodont.*, **41,** 819.
Miller, J. (1962), *Brit. dent. J.*, **112,** 308, 343.
Richardson, M. E., Adams, C. P., and McCartney, T. (1963), *Trans. europ. orthod. Soc.*, 285.
Salzmann, J. A. (1938), *J. Amer. dent. Ass.*, **25,** 892.
Schachter, H. (1943), *Brit. dent. J.*, **75,** 57.
Seipel, C. M. (1946), *Svensk. tandläk. Tidskr.*, suppl. 39.
— — (1947), *Ibid.*, **40,** 407.
— — (1949), *Dent. Rec.*, **69,** 224.
Turner, J. G. (1931), *Proc. R. Soc. Med.*, **25,** 1643.
— — (1934), *Brit. dent. J.*, **56,** 623.
Ungar, A. L. (1938), *Amer. J. Orthodont.*, **24,** 613.

SIMPLER CERVICAL TRACTION

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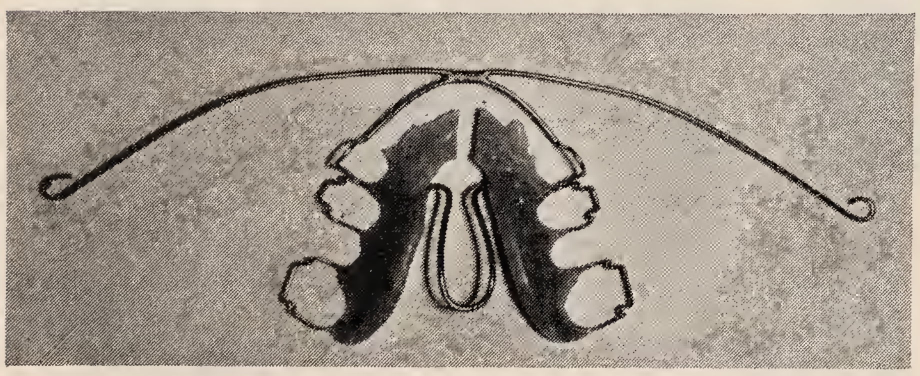
IN his Presidential Address to this Society in 1961, McCallin outlined a technique of extra-oral traction using a petersham headband with elastics and wire hooks to provide the transmission of force to an intra-oral removable appliance.

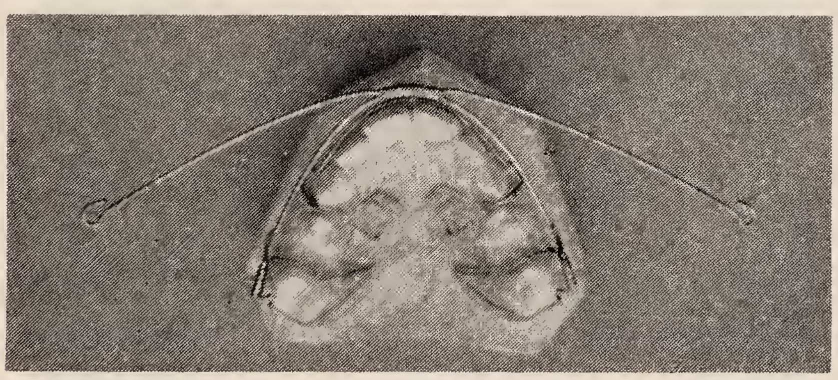
He stated: ' The secret of success lies in the design of the appliance and its extra-oral components which must be easy for the patient to manage and tolerate. I suggest that one of the main reasons why this technique has not been popular in the past is because the headcap or

A B

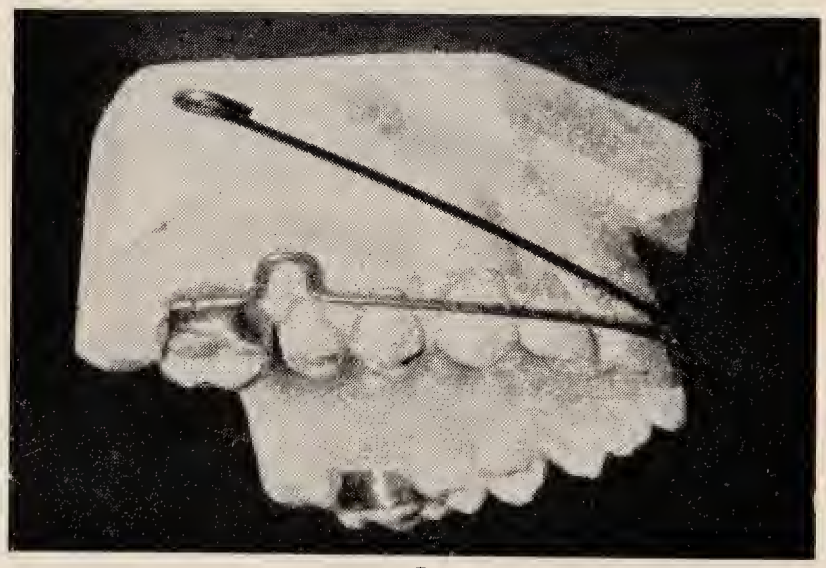
Fig. 1.—Profile photographs, A, the passive lateral position of the whiskers before attachment to the headband and, B, activated under tension after attachment.



A



B



C

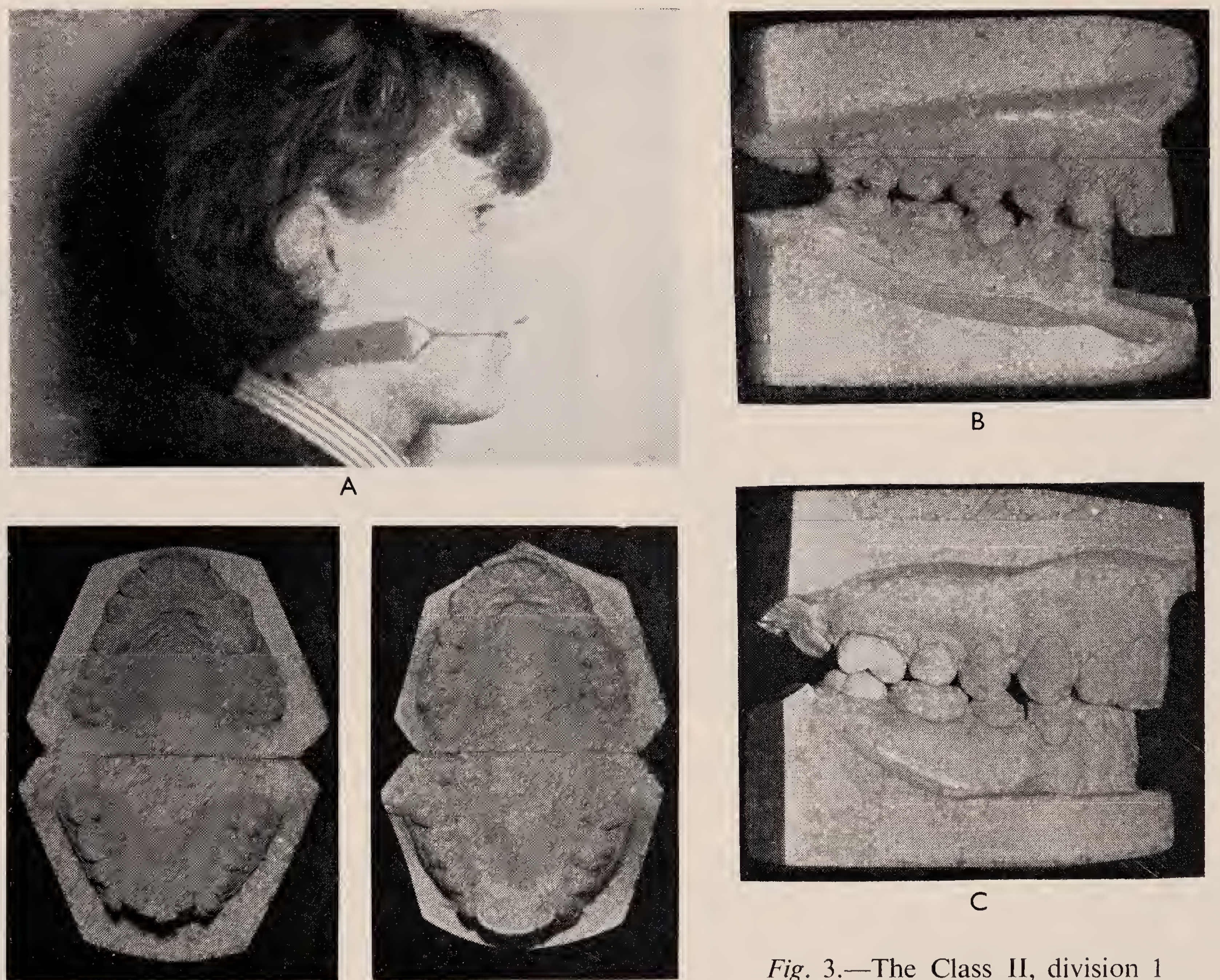
Fig. 2.—Three types of attachment of the whiskers to the intra-oral appliance: A, The McCallin removable appliance. B, Removable whiskers and arch wire with U-loop stops in 10-mm. tubes on the $\underline{6|6}$ Adams' clasps of a removable appliance. C, Similar removable whiskers and arch wire in tubes on $\underline{6|6}$ bands. A combination of this fixed and a removable appliance is often used.

Presented at the Country Meeting held in Birmingham on 30 April, 1965.

cervical harness has been tedious to make, uncomfortable to wear, and liable to become unhooked.'

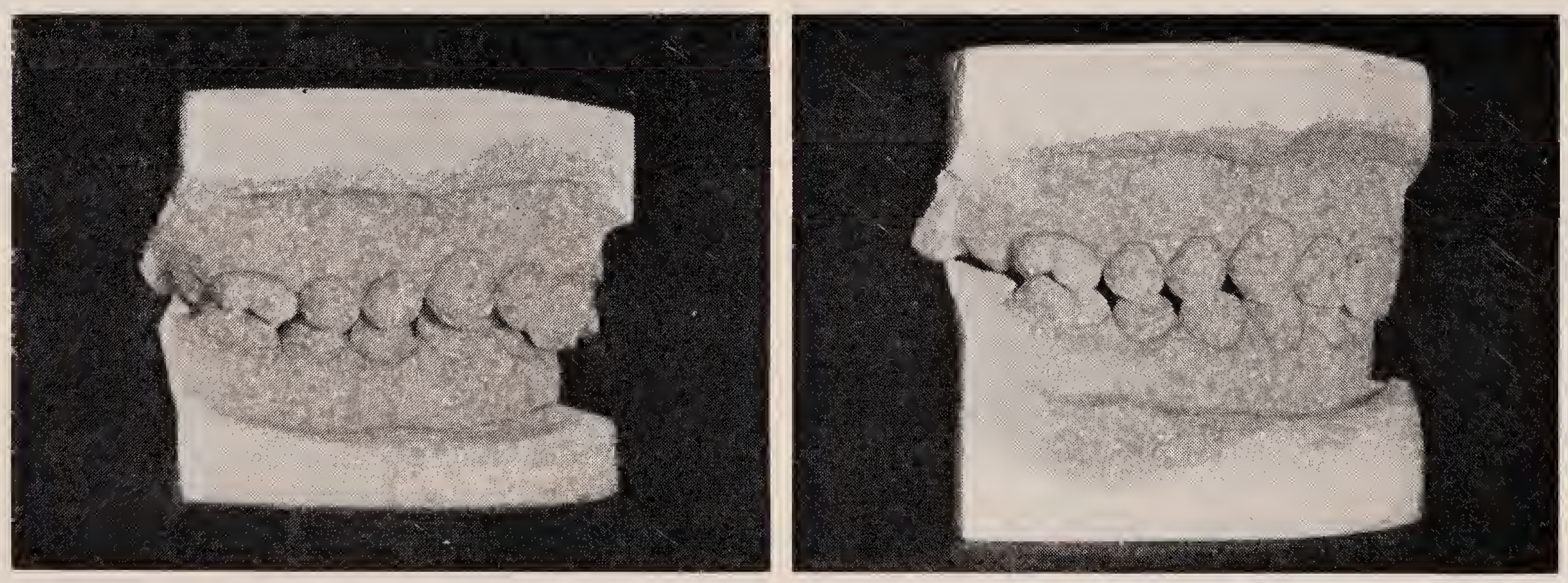
Any attempt therefore to simplify this apparatus even further should be worthy of record, and for the past 2 years I have been using a modified appliance which discards the most troublesome part, the elastic bands, and transfers the activation from the headgear to the arch-wire assembly (*Fig.* 1).

It consists of a simple petersham or plastic neckband which hooks directly on to the whiskers of the intra-oral appliance, which are made in the more resilient gauge of 1·0 mm.



A B C D E

Fig. 3.—The Class II, division 1 case showing, A, extra-oral view, B, lateral view of models before and, C, after treatment, and D, occlusal view of models before and, E, after treatment.



A B

Fig. 4.—The Class II, division 2 case, A, before and, B, after treatment following early loss of the $\frac{6|6}{6|6}$.

instead of 1·25 mm. wire. In their passive state these whiskers project almost laterally, so that when they are hooked back the natural tension in the wire provides the anteroposterior traction necessary, without any contracting effect on the intra-oral arch wire. The whiskers can be attached to the intra-oral appliance in the usual ways (*Fig.* 2).

A typical treated case is shown in *Fig.* 3, with the extraction of $\frac{7|7}{4|4}$ in a Class II, division 1 malocclusion. A strong retracting effect of the lower lip meant leaving the lower incisors alone in their stable retroclined position, and relief of crowding was obtained by retracting the $\overline{3|3}$ and aligning the lower incisors with a multiband appliance after the extraction of the $\overline{4|4}$.

The $\underline{7|7}$ were extracted rather than the $\underline{4|4}$ for fear of the latter providing too much room anteriorly. The upper buccal segments were moved back with cervical traction to a stopped arch wire in tubes on $\underline{6|6}$ bands, combined with an upper removable appliance to move back the premolars. The upper labial segment was eventually retracted with a free-sliding arch and a combination of cervical and intermaxillary traction.

Fig. 4 shows a Class II, division 2 case where $\frac{6|6}{6|6}$ had been lost early and the second molars had erupted in a forward position. Distal movement of the upper buccal segments was carried out with an upper removable appliance, reinforced with cervical traction pulling on a stopped arch wire, fitting into tubes on the Adams' clasps. The $\underline{2|2}$ were also eventually retracted with a removable appliance.

Acknowledgement

I would like to thank Mr. S. G. McCallin for lending me the slides of his cervical apparatus.

REFERENCE

McCallin, S. G. (1961), *Trans. Brit. Soc. Orthodont.*, 1.

DISCUSSION

Mr. D. H. Oliver asked the age in the case just shown.

Mr. H. L. Leech, in reply, thought about 12 years of age.

The President asked if any trouble had been experienced with the soldering of the arch wire due to the thinner wire.

Mr. Leech said he occasionally had a breakage, but no more than he usually had when using other types of cervical traction.

The two parts of the appliance were first of all welded together, then 0·5 mm. soft wire was wound around the two main wires and all soldered together.

Mr. H. G. Watkin said that he used plenty of solder and made it like a plumber's wiped joint. It was then all right.

Mr. G. C. Dickson asked if there were any means of adjusting the arch, because surely as the extra-oral traction pulled the thing backwards so the whiskers would widen. He thought it would stick out away from the cheek.

Mr. Leech said that in actual fact he did not get any trouble with these, and he did not find it necessary to shorten the whiskers at all.

The President said the answer was that the amount of bending which had to be done was about 1 inch, and that the amount of tooth movement one hoped to achieve was considerably smaller than that. It would therefore remain active for a long period.

Mr. P. I. Townend asked if he had tried using Coffin springs the other way round, so that the loop is at the anterior end. This would appear to be the logical way of fitting the opening spring and simplified adjustment.

Mr. Leech said that he had never done it, but it might well be successful.

COMMON SENSE IN ORTHODONTICS

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In my paper read at the meeting of the European Orthodontic Society in Newcastle (Neumann, 1963), I tried to point out how different concepts of orthodontics developed in different countries by the adaptation of orthodontic theory and practice to the prevailing socio-economic and psychological conditions. Being uncertain how this idea would be accepted I was very pleased indeed by the approval expressed during the discussion. When, however, during my stay in England after the meeting, I had the opportunity to get a closer look at orthodontics in this country I was very much surprised. I not only found that orthodontics, in adapting itself to the conditions created by the spreading of orthodontic treatment under the National Health Service here, had developed a most interesting concept of its own, but that, although the way orthodontic treatment is organized and carried out here is quite different from the way it is done in Czechoslovakia, there is a similarity on essential points, making experience gained here very useful for us.

In both our countries a National Health Service led to a sudden and enormous increase in the demand for treatment and in both countries there were not enough orthodontists to cope with the demand. In Great Britain general dental practitioners had to provide a larger part of the orthodontic treatment than probably anywhere else, and this in turn led to a simplified doctrine suitable for teaching to students and for use by the family dentist. This process fascinated me, because it was very similar to the ideas I had developed from my own studies as well as from practical experience, and I felt encouraged to proceed further in this direction. The kind of orthodontics which so evolved seemed perfectly epitomized by the words: ‘ Orthodontics is just common sense ’ (Tulley, 1959).

This statement poses two questions. Can it be justified theoretically and how does it work in practice? It seems appropriate to look to common sense for guidance if there is neither a set of rules nor reliable information to solve the problem. Orthodontics is the branch of dentistry dealing with the diagnosis and treatment of malocclusion. The term ‘malocclusions’, however, is not defined, the reasons for treatment cannot be stated unequivocally, and consequently the indications for treatment are vague. There is no general agreement about the best way to undertake treatment, and no reliable information about the results achieved by different treatment procedures.

If we regard malocclusion as the opposite of normal occlusion, it is impossible to define one without defining the other. To define normal occlusion, however, seems impossible.

Professor Häupl (1955) wrote: ‘ The transition from eugnathism to dysgnathism is gradual as from day to night. It is impossible to draw a sharp dividing line. Only those cases of dysgnathia needing treatment are of practical importance but orthodontists may differ in deciding exactly which these are among themselves.’

Schwarz (1961) frankly admitted the impossibility of defining normality in the realms of natural science, but claimed that a capable diagnostician is able to recognize by experience, and sometimes also intuitively, what is irregular, in other words what is diseased or the otherwise abnormal.

Salzmann (1948a) stated: ‘ Structure, form, and function may be considered within the concept of normality as long as they do not reflect a disease process. Since there is no sharp dividing line between health and disease, the extremes in the range of natural variation present difficulties in clinical diagnosis. In the final analysis, “ normal ” as applied to structure, form, and function in orthodontic diagnosis falls well within the subjective responses of the individual orthodontist without direct relation even to arbitrary definitive criteria such as those based on so-called standards ’; and in another article (1948b) summarized that thought: ‘ Since the limits of normal dentofacial variation have not as yet been definitely established, there can be no general agreement as to what is, or is not, normal.’

To define normality and abnormality for statistical investigations, therefore, is not possible, because as Seipel (1946) put it: ‘ It is a question of an uncertain line of demarcation between a fictitious conception of the term normal and a heterogeneous collection of variations and anomaly symptoms.’

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It is not possible either to define malocclusions by their pathological origin or pathological consequences.

Already in 1944, Hellman had stated: 'Diagnosis in orthodontia is not to be taken in the same sense as it is in medicine, because malocclusion of the teeth is not a disease. Malocclusion of the teeth is a malformation of the organ of mastication and the tissues involved are essentially unaffected by pathological conditions.'

Hotz (1951) asked in his article ' Causes of Malocclusions ' : ' . . . Is it not rather a case of a type of constitution manifested in the region of the jaw, of variation in form, possibly in function, that are not pathological? Are these not only ontogenetic expressions of phylogenetic development, favoured by peculiar circumstances or accidentally of marked character ? May the word " aetiology " here be used at all in the sense of a cause of disease ? '

In their *A Manual of Practical Orthodontics*, Tulley and Campbell (1960) advise that 'although the term malocclusion suggests any deviation from the ideal normal, it should not be used in its narrowest sense. Many occlusions are not ideal but are functionally and aesthetically acceptable.'

I feel myself that there should be a range of normality comprising not only the ideal normal occlusion, but also all these other common normal occlusions as well. We should regard as malocclusions only those which can justifiably be regarded as disturbing and/or detrimental to the individual concerned, and whose treatment is at least theoretically indicated, although it may not be feasible in a large number of cases.

The definition of the ideal normal occlusion need not be difficult, but the demarcation between the ' common normal ' and abnormal is of necessity influenced by the psychological and socio-economical conditions of the environment, because it is related to the reasons and indications for treatment. This approach becomes more obvious by a comparison of the views held in different countries.

Borgmann (1954) had 505 children, aged 9–10 years, examined independently by 5 orthodontists, who found that about 25 per cent of them urgently needed treatment for health reasons, because their malocclusions were ' a functional disturbance of the stomatognathic system and endanger it by premature loss of teeth, by caries and paradontal disease.'

To my knowledge no proof has ever been offered that such consequences are in fact to be expected. Lundström (1949) said that ' malocclusions probably play quite an unimportant part as regards the aetiology of these tooth diseases. What primarily determines whether we have a high or low caries frequency, or whether a disposition to parodontal disease as well as resistability to this disease, surely depends upon entirely different factors. If, on the other hand, there is a marked tendency to caries or parodontal disease, there the consequences will without doubt become more serious, if there are certain simultaneous malocclusions.'

There is very little justification for advocating orthodontic treatment as a prophylactic measure against caries and parodontal disease, because there is no evidence that such a measure would be effective if undertaken. Even if such evidence were forthcoming there would be only a few malocclusions whose treatment would be indicated just for these reasons, without any functional or aesthetic indications. German orthodontists, nevertheless, are emphasizing the health of the mouth as a reason for treatment, and there is a danger that such teachings may be used to justify indications for treatment beyond the reasonable limits set by aesthetic and functional considerations.

Further indications for treatment may result from the greater ease with which any kind of desired tooth movement may be obtained by the refined and intricate fixed appliances now used in the United States. The facetious definition of tooth movements as a ' pathologic process from which the tissue recovers ' quoted by Graber (1961), indicates that the potency of the appliances used carries with it the danger of attempting to achieve too much. There is also the risk that treatment may be started for trivial reasons.

The divergence of views shown by these examples is not mitigated by a steadily increasing volume of scientific research, which usually only provides a general background for better understanding of the problems involved instead of giving guidance for their solution in individual cases. The indications for treatment, the aims of treatment, and also the means to be used have therefore chiefly had to be determined by experience and common sense.

This fact as well as other theoretical and practical considerations made it desirable to find out something more about the incidence of malocclusion, to define clearly variations in occlusion, and evaluate the relative importance of their treatment needs. The municipal paedodontic department of my home town is next to our orthodontic department. All children from the neighbouring schools are treated there; whole classes escorted by the teachers come to the the clinic. The kind co-operation of the teachers and the dentists in charge enabled us to examine 1525 children, aged 13–15 years. In Czechoslovakia children start school at the age of 6 and stay there for the next 9 years.

We examined 85 per cent of the children in the top three forms. One-third of the children not examined were absent from school, the rest unfortunately were classes or parts of classes we were unable to see. All the children attending the paedodontic department are examined twice annually and all cavities detected are filled.

The records of treatment were at our disposal, and we obtained from them the number of DMF teeth of each child, in order to compare the caries incidence of normal occlusion and different malocclusions. For every child a hectographed form was filled out. Björk, Krebs, and Solow (1964), from Copenhagen, have recently published an extremely interesting method for registering tooth position. The data obtained by this was very detailed and had to be analysed by an electronic computer. It was possible, however, to use some features and definitions of this method for our own extremely simplified study. For every child a note was made of the type and extent of any symptoms of malocclusion present and according to the extent of the abnormality treatment needs were estimated.

The survey was concluded a few weeks ago, and I hope the records when studied in detail will yield information on some points of interest. A provisional counting gave the following results.

Children with anterior teeth in perfect or good alinement were divided into three groups. In these groups, molar or premolar irregularities, when present, were put into six different categories. 14·3 per cent of the children had the anterior teeth in perfect or almost perfect alinement, or at most a nearly unnoticeable crowding. 2·6 per cent, however, had some malocclusion in the molar or premolar region, leaving 11·7 per cent with an ideal or almost ideal occlusion. 16 per cent had very slight crowding, the total lack of space not exceeding 2 mm., and/or a nearly unnoticeable overjet of the upper incisors. 4·6 per cent from that group had malocclusion in the molar or premolar regions. 18·7 per cent had very slight deviations, such as crowding with 2 mm. lack of space. If, however, the crowding was very evenly distributed and barely noticeable then a lack of space of up to 3 mm. was accepted. Other slight deviations were overjet of less than 4 mm., or an upper midline diastema up to 2 mm. 5·8 per cent from that group had premolar or molar malocclusions.

The above three groups together constitute 49 per cent of all the children, made up of 13 per cent with and 36 per cent without disturbance in the premolar and molar region. Nearly one-third of the malocclusions in that region were more or less undesirable cross-bites or complete lingual occlusions of the lower teeth. Such malocclusions are not easily amenable to treatment by removable appliances and the lack of space was not enough to justify extractions. As these children had a satisfactory appearance it was considered they would be unlikely to co-operate to any great extent if treatment to correct these irregularities was undertaken. Some of the remaining two-thirds needed at the most extraction of displaced premolars, and quite a number were in need of no treatment at all.

The next group, comprising 18·6 per cent of the children, had slight malocclusions, such as overjet of 4–5 mm., nearly unnoticeable crowding of the upper canines, more distinct crowding of the incisors, especially the lower, and similar conditions. Treatment of such conditions is practically never requested, and if it were we would attempt to dissuade the parents.

Of those examined 7·1 per cent had malocclusions whose treatment would be undertaken if it were desired by the parents. These patients had an overjet of 5–6 mm. or upper canines in a noticeable but moderate malposition, which would not prevent their being used as abutments in prosthetic restorations at a later age.

16·5 per cent had malocclusions which required treatment; a further 8·8 per cent had been or were still under treatment. All the treatment had been undertaken at our health centre. The records of these cases will eventually be examined in order to regroup these patients according to their initial diagnosis, so that we can reconstruct an entirely untreated sample for our statistics.

Only 30·4 per cent of the children had an overjet of the upper central incisors of 4 mm. or more. An overjet of 4–5 mm. was found in 15·8 per cent. Lundström (1959) regards an overjet up to 5 mm. as being within the range of normality. 85·4 per cent of the children examined did not exceed that limit. A small number had one or more incisors inside the bite. We did not differentiate these cases in the preliminary counting. An overjet from 5 to 6 mm. was measured in 7·6 per cent of cases. Björk and co-workers (1964) divide extreme overjet into two grades: Grade I, 6–9 mm.—we had 6·3 per cent of cases in it—and Grade II, which is an overjet of more than 9 mm.—we had only 11 children, 0·7 per cent of cases. Results of treatment may have diminished the number of cases in the last two groups, but hardly enough to influence significantly their order of magnitude.

In a future detailed analysis the above groups will be subdivided, and it may be advisable to redefine some dividing lines between them.

As mentioned above, 16·5 per cent of the children had contracted malocclusions which needed treatment according to generally accepted views. Treatment was therefore offered to many of them, but only a few were interested. They did not want to wear appliances or have teeth extracted, and apparently were unconcerned about their appearance being poor. There were, however, also quite a number of youngsters, especially with overjets from 6 to 7 mm., who looked quite reasonable despite their malocclusions, which were, in some cases, quite unnoticeable to the casual observer. Finally, there were cases of open bite, mandibular prognathism, or deep buccal cross-bite with the canine involved, where orthodontic treatment would have next to no chance of success. Many

of these could have their anomaly corrected later by surgery.

The special reason for selecting older children was in order to get information about the total number of malocclusions. Without treatment they accumulate and are most conveniently counted when the permanent dentition is present or at least nearing completion. We wanted to know how many children needed treatment and why, how many had been treated and with what results, and how many needing treatment had, in spite of orders given to the paedodontists, not been sent to our centre. We were interested, too, in how the dentition of the children not needing treatment looked. Already the preliminary results of our survey indicate it is possible to advocate the treatment of any percentage of the school population you like; the treatment of about 20 per cent would appear to be reasonable, however, although due to technical and psychological factors the actual number having it done will be very much smaller. It would have to be convincing proof that any increase in the number of children treated above such a level could bring results which are worth while.

It is a pity that many malocclusions, especially those easily improved by extractions, are not treated. The essence of our health service is not to wait till patients come to see the doctor or dentist, but wherever possible to prevent disease or detect it early enough to treat it with the best results. We shall therefore have to try to change the attitude of children and parents towards orthodontic treatment even if it is going to be a slow and difficult process.

By registering all ‘ shades ’ of occlusal abnormalities, gradual transition from perfect occlusion to gross malocclusion can be easily demonstrated, but this also shows the difficulty of drawing a line between whether to treat or not to treat. That decision may be influenced by the chances of success, but the difficulties of treatment need not correspond to the size or type of the anomaly, whose appearance can often be deceptive. This is because the interplay of genetic and environmental factors causing it can only rarely be satisfactorily determined and evaluated in the individual.

I must confess I never realized how much these difficulties were overcome during orthodontic diagnosis and treatment planning by a logical step by step process, based on experience but guided by common sense. The importance of the deviation from the normal for the patient is evaluated. Having made a preliminary decision about treatment, the skeletal pattern and soft tissues are now examined in detail, the attitude of the patient and parents considered, and if necessary a reappraisal of the preliminary decision made. It was very surprising to me, how easily an intelligent postgraduate student can be introduced into clinical practice if taught to follow such a scheme—somewhat more elaborate of course but guided by logic and common sense.

For a similar approach to treatment planning I cannot do better than quote Hovell’s (1962) own order of preference.

First: No orthodontic treatment at all and the acceptance of minor irregularities.

Second: Extractions with no active orthodontic treatment.

Third: Minimal simple appliance therapy with or without extractions.

Last: Complicated appliance therapy.

If we are ready to accept minor irregularities and not interfere in border-line cases, we often see surprising improvements to justify our ‘ masterly inactivity ’.

Eminent specialists (Korkhaus, 1962) have expressed the opinion that extraction generally does not simplify or shorten treatment, and also that in serial extraction cases a period of appliance therapy will be generally necessary (Graber, 1961). I think we all have often seen wonders of self-adjustment after extractions giving perhaps not a perfect but at least a very acceptable occlusion.

A large proportion of malocclusions are caused by genetic factors. If the genetically determined size of the teeth is too large for the genetically determined size of the jaw, extractions, by putting the imbalance right, provide the only chance of changing the genetic pattern.

The preponderance of genetic influence in the aetiology of malocclusion is acknowledged. An orthodontic appliance is an artificially added environmental factor acting late and of comparatively short duration. We cannot, therefore, expect too much from our appliances, and it is quite marvellous how much is achieved by skilled clinicians.

I think that most of what I have tried to say today has been said here before and been expressed much more perfectly by Rix in his foreword to the textbook of Tulley and Campbell (1960), but I thought it might be worth while to discuss the subject from a different point of view.

As I said at the beginning of this paper, what I have seen in this country has greatly encouraged me to develop my ideas further. In conclusion, therefore, I would like to emphasize the following points.

Simplicity in orthodontic treatment is a virtue granted us, not a limitation imposed on us, and although we go about it in quite different ways we have much in common in our practice as well as in our aims and goals. The more we learn to know each other and understand each other, the better for all concerned, and that is not necessarily limited to orthodontics.

There are many problems in orthodontic theory and practice which are very complicated

and will, we hope, be solved in time to come by persistent research and advanced clinical experience. But a large part of our daily tasks can be solved best simply by applying common sense. When Professor Tulley said, ' Orthodontics is just common sense ', it was perhaps only a chance remark in a discussion. But I think it is a very important statement, and I have never read a short sentence that has helped me so much.

Acknowledgements

I wish to thank Mr. A. G. Huddart and Professor W. J. Tulley for reading the manuscript and for many helpful comments, and Professor Tulley, again, for providing secretarial assistance while I was in England.

REFERENCES

Björk, A., Krebs, A., and Solow, B. (1964), *Acta odont. scand.*, **22,** 27.

Borgmann, H. (1954), *Zahnärztl. Mitt.*, 587.

Graber, T. M. (1961), *Orthodontics: Principles and Practice.* Philadelphia: W. B. Saunders Co.

Häupl, K. (1955), *Die Zahn-Mund-und Kieferheilkunde*, vol. 5. Munich and Berlin: Urban & Schwarzenberg.

Hellman, M. (1944), *Angle Orthodont.*, **13,** 1.

Hotz, R. (1951), *Int. dent. J., Lond.*, **1,** 50.

Hovell, J. (1962), *Trans. europ. orthod. Soc.*, 293.

Korkhaus, G. (1962), *Zahnärztl. Mitt.*, **13,** separate reprint.

Lundström, A. (1949), *Trans. europ. orthod. Soc.*, 147.

— — (1959), *Dent. Practit.*, **9,** 129.

Neumann, B. (1963), *Trans. europ. orthod. Soc.*, 225.

Salzmann, J. A. (1948a), *Amer. J. Orthodont.*, **34,** 297.

— — (1948b), *Ibid.*, **34,** 732.

Schwarz, A. M. (1961), *Lehrgang der Gebissregelung*, vol. 1, 3rd ed. Vienna: Urban & Schwarzenberg.

Seipel, C. M. (1946), *Svensk tandläk. Tidskr.*, **39,** suppl.

Tulley, W. J. (1959), *Brit. dent. J.*, **107,** 199.

— — and Campbell, A. C. (1960), *A Manual of Practical Orthodontics.* Bristol: John Wright & Sons.

DISCUSSION

Mr. A. G. Huddart, opening the discussion, said Dr. Neumann had put forward a very interesting concept. It took a lot of moral courage to say what he did, because he had put down in black and white the criteria by which one deduced whether or not a patient should be treated. Adopting those criteria about 20 per cent of children would need orthodontic treatment.

Did Dr. Neumann feel it was justifiable to fit a multiband appliance in order to upright the lower second premolar and second molar, which had tilted towards each other following the loss of the first molar ?

Dr. Neumann, in reply, said it was probably right to say that demand for treatment in Czechoslovakia was not so great as it was here, because in his own region he had fifty areas under his control and he never encouraged demand which he did not think to be reasonable. He never refused parents what they wanted if somehow he could accommodate them.

UNILATERAL CRANIOFACIAL DEFORMITIES

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INTRODUCTION

THE orthodontist with his specialized knowledge and interest in growth and development of the craniofacial regions is an important member of the team which decides the diagnosis, prognosis, and treatment of patients with craniofacial deformities. The subject, however, is so vast that only some unilateral abnormalities will be considered in this paper.

HEMIFACIAL HYPERPLASIA AND HEMIFACIAL HYPOPLASIA

Considerable confusion appears in the literature on the terminology of over-growth and under-growth of the face. They can, however, be classified as follows:—

1. Hemifacial hyperplasia, complete or partial.
2. Hemifacial hypoplasia, complete or partial.
3. Hemifacial atrophy.

Hemifacial Hyperplasia and Hemifacial Hypoplasia

Hemifacial hyperplasia and hemifacial hypoplasia must be considered together, and separately from hemifacial atrophy, which, as its name suggests, is a wasting of the tissues of one side of the face. Hemifacial hyperplasia and hypoplasia describe conditions where half or part of one side of the face is greater or less than normal. Both conditions are usually congenital, but partial hemifacial hypoplasia or hyperplasia might be acquired. The main difficulty in both these cases is to decide which half of the face is normal and whether it is a case of hyperplasia of one side or hypoplasia of the other side.

Complete symmetry of the human body does not exist, there being always a slight variation of the size and shape from side to side. Occasionally, however, these variations assume a degree which is noticeable, and at this stage it becomes hyperplastic or hypoplastic.

In hemifacial hyperplasia there is usually an enlargement of any or all of the tissues that make up one side of the face. Burke (1951, 1957) and Broadway (1964) have published details of cases in which all the tissues affecting one side of the face, including the teeth, were larger than normal.

A common form of unilateral mandibular hyperplasia is that in which there has been excessive increase in the size of the right side of the mandible. The diagnostic features are the flattening of the cheek on that side and the increased gonial angle. The chin is deviated towards the normal side, producing a severe cross-bite on that side and a good occlusion on the abnormal side.

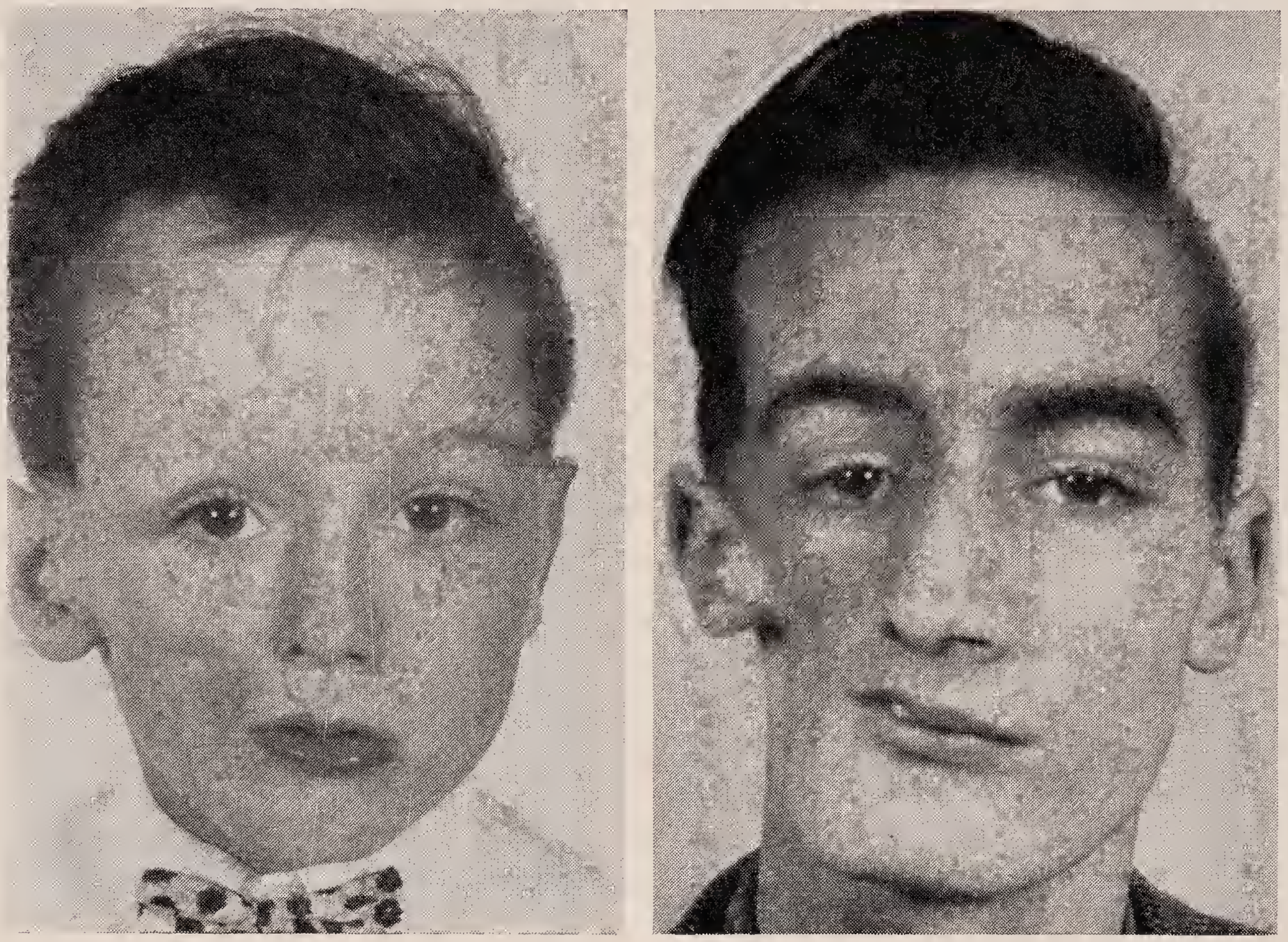
Occasionally one-half of the tongue is much larger than the other, and as the enlargement is confined to one-half of the tongue this is a true congenital unilateral hyperplasia of the tongue. The muscles of the tongue and mouth function normally, but there are some secondary complications. Owing to the increased bulk of the tongue, speech is slightly impaired and there is mild dyslalia. The jaws and dental arches are usually all well developed, but fail to accommodate this large tongue, with the resulting anterior open bite. This open bite is more severe on the normal side to which the tongue deviates on swallowing.

Hemifacial hypoplasia must not be confused with hemifacial atrophy, in which there is a wasting of the tissues and not just a reduction in size. Auriculofacial hypoplasia, in which there is deformity of one side of the face due to a first arch defect, will not be considered in this category, but will be considered separately. Hemifacial hypoplasia has been described by many writers and especially by Burke (1951, 1957) who gave details of a case with a diminution of all tissues on one side of the face, including the teeth themselves. Localized hypoplasia of the mandible may occur, owing to infection or trauma to the growing condylar head. This produces a typical facial deformity, the severity of which depends on the degree of damage to the head of the condyle and the age at onset. The diagnostic features are the lack of height of the vertical ramus, combined with pregonial notch of the lower border of the mandible on that side. There is usually ankylosis or limitation of movement, while the maxilla may be prevented from growing properly on that side, and there may be an associated elevation of the occlusal plane. The chin will be deviated to the defective side.

Presented at the Country Meeting held in Birmingham on 30 April, 1965.

Hemifacial Atrophy

As its name implies, hemifacial atrophy is a wasting of one-half of the face. This is always acquired and may occur at any age, but is often seen in young children between the ages of 2 and 10 years. The atrophy appears as a small pigmented area, usually in a specific part of the cheek, angle of the mouth, or of the temporal or buccinator muscle. This small pigmented patch spreads across the face and may eventually involve one half of the face, scalp, and neck (*Fig.* 1). It has never been known to cross the midline. The skin is deeply pigmented, dry, and parchment like, but is freely movable with no impairment of function. The subcutaneous fat completely disappears, leaving nothing to separate this dry skin from the underlying muscle and bone, which it covers tightly. The facial deformity produced by this atrophy is severe, with a twisting of the face and skull towards the affected side. There is a retardation of growth of all bones on that side, and there is usually an elevated occlusal plane. The lips are usually contracted and carry a permanent sardonic grin, through which the incisors protrude. The tongue is often affected, producing a severe reduction in size of the appropriate side. The roots of the teeth on the atrophic side show varying degrees of root shortening, and the length of the roots of these teeth depend on the degree of calcification already established at the onset of the atrophy (Glass, 1964). Incisors are less affected than premolars and canines, which, presumably, were developing at the onset of the atrophy. The atrophy progresses along an unpredictable and uncontrollable course, which is confined to that half of the face, and no treatment can influence this. Spontaneous arrest, however, usually occurs after some years, following which no further atrophy occurs.



A B

Fig. 1.—A, An early case of hemifacial atrophy. B, Severe case of hemifacial atrophy causing considerable craniofacial distortion. The atrophy never crosses the midline.

This condition has been considered to be a localized facial scleroderma and may be connected with progressive lipodystrophy which, however, occurs bilaterally. The atrophy is probably associated with a neurotrophic disorder.

FACIAL PARALYSIS

The commonest paralysis of the face is due to damage of the 7th cranial nerve.

The lesion may be intracranial or extracranial. The intracranial paralysis is usually due to trauma pressure from a tumour, or a haemorrhage, and is a common feature in hemiplegia.

Peripheral 7th nerve lesions produce the facial paralysis most commonly seen. The aetiology is usually traumatic, infective, or due to a cold. Birth injury, surgical accident, and infections may produce complete and lasting hemifacial paralysis.

Bell's palsy is the facial paralysis associated with cold, and is due to the swelling of the nerve as it emerges from the cranium. This swelling,

being confined within the bony foramen, compresses the nerve and causes paralysis. Typical features are; a rapid onset with the affected side having a sagging appearance, and being drawn across to the sound side when the muscles are activated. The forehead is smooth and cannot be wrinkled on that side and the eyelids cannot be closed. This may lead to an infective conjunctivitis. Food tends to collect in the buccal sulcus and is not removed by the normal self cleansing muscles of the cheek. In cases where the palsy or paralysis is permanent it usually produces a caries-prone condition due to this lack of muscular self-cleaning, which results in the early loss of the teeth. Congenital and birth injury paralyses do not always produce upsets in the dental arches, but the occlusal plane may occasionally be seen to be lower on that side than on the normal. Another type of paralysis or paresis may be found in which there is a partial paralysis of the lips, tongue, and soft palate. This has been called by Worster-Drought (1956) and Glass (1962), ' suprabulbar paresis ', and is probably of congenital origin caused by intra-uterine damage to the suprabulbar area. The differential diagnosis is that the lips are uncoordinated and the tongue cannot be elevated, while the speech is affected by the paralysis of the tongue and the soft palate. Owing to the incompetent lips, constant dribbling is a feature in these cases and there is a very powerful throwback swallow. Malocclusion is not marked but open bite is a common feature and is due to an uncoordinated tongue thrust in the attempts to swallow. Owing to the lack of normal self-cleansing action of the muscles, deterioration and early loss of the teeth is a common feature.

A

B

Fig. 2.—Muscular torticollis causes severe craniofacial deformity, with the face twisted away from the affected side. The sternomastoid muscle is reduced in length and thickness.

WRYNECK OR TORTICOLLIS

This term is used to describe a common deformity of the neck seen in infancy and which may produce secondary facial deformities of interest. There are three types of torticollis:—

1. Postural torticollis.
2. Structural torticollis.
3. Muscular torticollis.

All three are included in the term ' wryneck '.

Postural Torticollis

Postural torticollis is usually due to a postural habit of holding the head to one side. This can cause gradual craniofacial deformity, but is not usually very severe.

Structural Torticollis

Structural torticollis is due to structural defect of the cervical vertebra and surrounding

bones and may be associated with the Klippel-Feil syndrome and other congenital deformities.

Muscular Torticollis

Muscular torticollis is by far the commonest type of wryneck. The important feature is that the sternomastoid muscle on one side is much shorter than normal and may show considerable wasting. This condition is often associated with

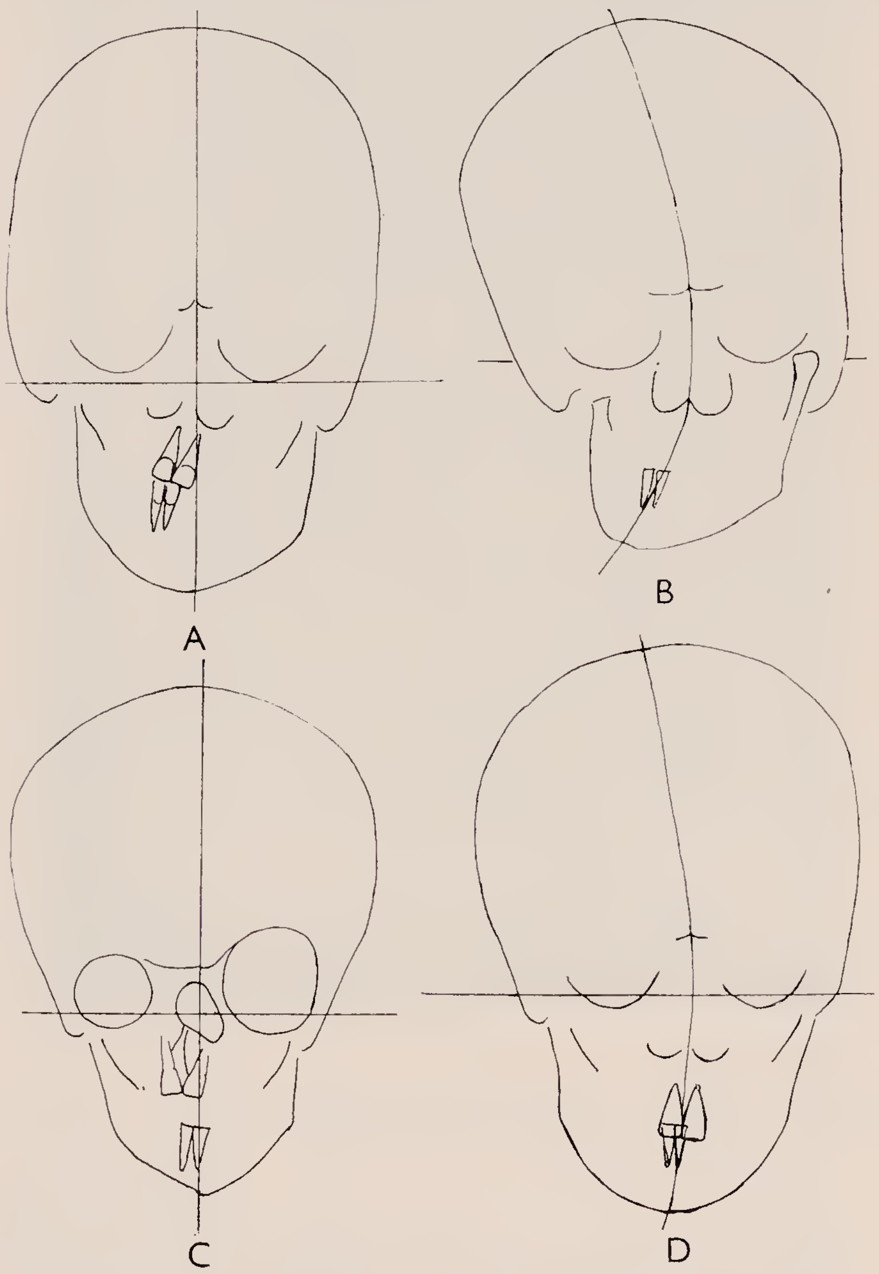


Fig. 3.—Tracings of cephalometric radiographs, the head being orientated on the Frankfurt plane showing the degree of craniofacial deformity in different defects. A, Hemifacial atrophy; B, Auriculofacial hypoplasia; C, Anophthalmia right eye; D, Muscular torticollis.

a hard nodular tumour, which is noticed in the first few months of postnatal life, but has usually disappeared by 6 years of age. Following the gradual disappearance of this tumour there is a replacement and degeneration of the muscle-fibres by fibrous tissue (*Fig.* 2).

The craniofacial effects are secondary to the torticollis, and are probably due to atypical function and gravitational pull on the twisted head and face. The head is inclined towards the shoulder on the affected side, while the face is rotated to look upwards towards the sound side. The skull itself may show flattening of the parietal area on the sound side and bulging of the other side (*Fig.* 3). There is considerable asymmetry of the face with an apparent drooping appearance on the affected side. The eye and lips are all lower than normal, while the lips themselves may be somewhat depressed at the angle of the mouth and the occlusal plane may be lower on the abnormal side.

VASCULAR TUMOURS

Angiomas are tumours of the circulatory system and include all vascular tumours. The nomenclature and descriptive literature are extremely complex on this subject, but basically there are two main systems which may be affected, namely the blood-vessels and the lymphatic-vessels. Tumours of the former are known as haemangiomas, the latter lymphangiomas. These show a predilection for the face and neck and may produce secondary facial deformities of interest. Both tumours are not neoplastic, but are due to an aberration in growth during the embryonic angiogenesis of the area concerned and are always congenital, but not necessarily of genetic origin. In view of the disfigurement produced, even only temporarily, it is unfortunate that the head and neck is a common site for both these lesions.

Haemangiomas

These are much more common than lymphangiomas and occur in two forms:—

1. Capillary angioma.
2. Cavernous haemangioma.

The *capillary angiomas* being flat, slightly elevated lesions composed of dilated capillaries and having a characteristic port wine stain colour are a considerable disfigurement, but they do not cause any secondary deformities. Unfortunately, however, unlike cavernous haemangiomas they do not show any spontaneous resolution with age and are a permanency known as birth marks.

The *cavernous haemangiomas* or the ‘ strawberry mark ’ vary greatly in size and although the average size is that of a strawberry they may occasionally affect large areas of the face and limbs with severe disfigurement. These blood-vessel tumours are twice as common in girls as in boys, but fortunately most of them show spontaneous resolution before the age of six years. In large cavernous haemangiomas the facial bones may be distorted, probably owing to the abnormal environment and the gravitational pull of the weight of the tumour. The deformity may be demonstrated by the depression of the occlusal plane on the affected side, owing to increased height of the maxilla on that side. These tumours may affect the tongue, giving the appearance of hemimacroglossia. This, in itself, will produce the typical mandibular and maxillary deformities associated with an increased size of

the tongue, and the lateral open bite may be the only way that the tongue can be accommodated.

Lymphangiomas (*Fig.* 4)

These are less common than haemangiomas, which is fortunate in view of the fact that they occur almost entirely on the face and especially affect the tongue, combined with the fact that they do not resolve with age, making secondary craniofacial deformities more marked and more difficult to treat. Any facial and dental abnormalities occurring with cavernous haemangiomas will generally only affect the deciduous dentition and will be self-correcting with the resolution of the tumour, and the replacement of the deciduous teeth by the permanent teeth. With the lymphangiomas, however, the deformity continues to increase with the normal growth and development, and is firmly established by 16 years of age. There is no likelihood of any improvement with maturity. Surgical reduction of the soft tissues may give some improvement by reducing the bulk of the intra-oral or extra-oral tissues of the tongue or face.

Fig. 4.—Lymphangioma of the right side of the face. Note the increased volume of the cheek tissues and the sagging effect on that side of the face.

NEUROFIBROMATOSIS

Neurofibromatosis or von Recklinghausen's disease is a slowly progressive disorder which becomes more apparent at puberty. The main features are areas of pigmentation of the skin known as *café au lait* areas, in which may be found sessile or nodular tumours; also tumours of the nerve in that area. These may produce only slight local deformities or may cause gross variation in the size, producing localized gigantism of the limbs or digits concerned.

Cranial nerves are especially affected, and particularly the auditory nerve. In one case the neurofibromatosis affected the right half of the tongue and soft tissues of the cheek on the right side of the face. On examination at middle-age there was a considerable right-sided facial asymmetry with an enlarged mandible and hypertrophy of the tissue of that area of the cheek and tongue. The tongue itself was greatly enlarged on the right side, especially over the anterior two-thirds, and was much rougher than normal with a reddish texture due to enlarged surface papillae. The speech itself was somewhat affected by the tongue and cheek and also probably by the malocclusion. All teeth were present, except those of the right upper buccal segment. There was a Class III malocclusion with an anterior open bite, while the mandible was deviated to the right by the width of one upper incisor. The mandibular protrusion was probably due to a combination of a Class III prognathism and mandibular enlargement due to the neurofibromatosis.

There was considerable asymmetry of both sides of the face, the right side being much larger than the left.

The maxilla on the right side was greatly enlarged, especially in the antral area, with a compensating reduction in the size of the orbit. The upper maxillary arch was narrow, producing a cross-bite occlusion. The mandible was much larger on the right side, and the inferior dental canal was much wider and more irregular than normal. Skull radiographs showed the nasal area to be deviated to the right, while the vertical ramus on the right side was much shorter than that of the normal side, the angle being displaced outwards and upwards. There appeared to be no cranial involvement or abnormality.

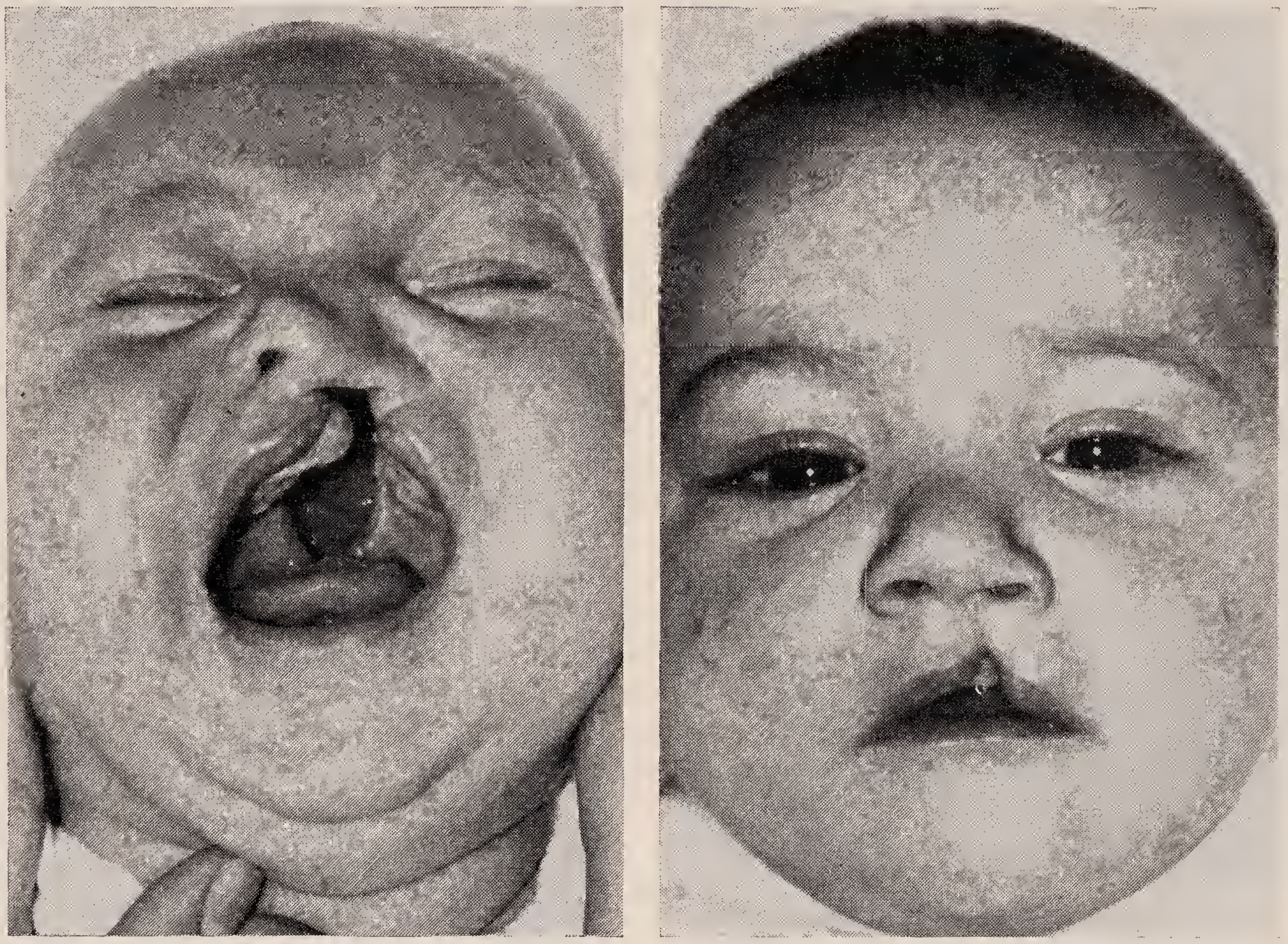
FIRST ARCH SYNDROME

Unilateral first arch defects include all developmental failures, either partial or complete, associated with the first branchial arch, especially with the embryonic tissues which combine together during the first few weeks of intra-uterine life to form the face. Two main groups of the deformity are unilateral clefts of lip, alveolus, and palate and auriculofacial hypoplasias. The latter has been called intra-uterine necrosis by Greer Walker (1961).

The commonest deformities associated with the first arch syndrome are the clefts of lip, alveolus, and palate. Unilateral clefts are twice as common in boys as in girls and twice as common on the left side of the face.

The severity of the deformity is mainly dependent on the degree of tissue deficiency, and varies from a subepithelial failure of the muscle of the upper lip to a complete unilateral cleft of lip, alveolus, and hard and soft palate, which separates the maxilla into two independent segments attached to the cranial base, with nasal and oral tissues forming one large cavity.

True cleft of lip occurs when the entire lip from mouth to nose is separated and is usually associated with cleft of the alveolus and the primary palate (*Fig.* 6A). The nose will be affected with the flattening of the alar cartilage on that side, while the dentition will be disorganized in the area of the cleft. The palate, however, is not necessarily affected, so that the maxilla will be in normal occlusion with the mandible. The premaxillary unit carrying the central incisors may be rotated outwards.



A B

Fig. 5.—A, Complete unilateral cleft of lip, alveolus, and palate. The most severe form of unilateral cleft. B, Partial unilateral cleft of lip only.

Fig. 6B shows an unusual cleft combination, partial cleft of lip and alveolus and cleft of soft palate. The hard palate is intact.

The more usual types of cleft are as follows:—

Complete cleft of lip, alveolus, and palate is the commonest cleft of its kind (*Fig.* 5A) and divides the maxilla into two separate segments. This cleft produces severe unilateral deformities. The nose is flattened and deviated, the lip is wide open, the alveolar arch, with no continuity in this area, will show the deformity of the tooth-bearing tissues, and the lateral incisors are usually affected. There may be one or two peg-shaped supernumeraries in this region, or there may be complete absence of the lateral incisor. The central incisor bordering on the cleft is often defective and distorted, as well as displaced. The palate itself being ununited, the oral and nasal cavities are continuous. This produces breathing, swallowing, and speaking problems.

Cleft of lip may be V-shaped, affecting the entire thickness of the lip but not reaching the nose, which is unaffected. This may be associated with small defects of the lateral incisors and may even be present with an alveolar notching, but no cleft (*Fig.* 5B).

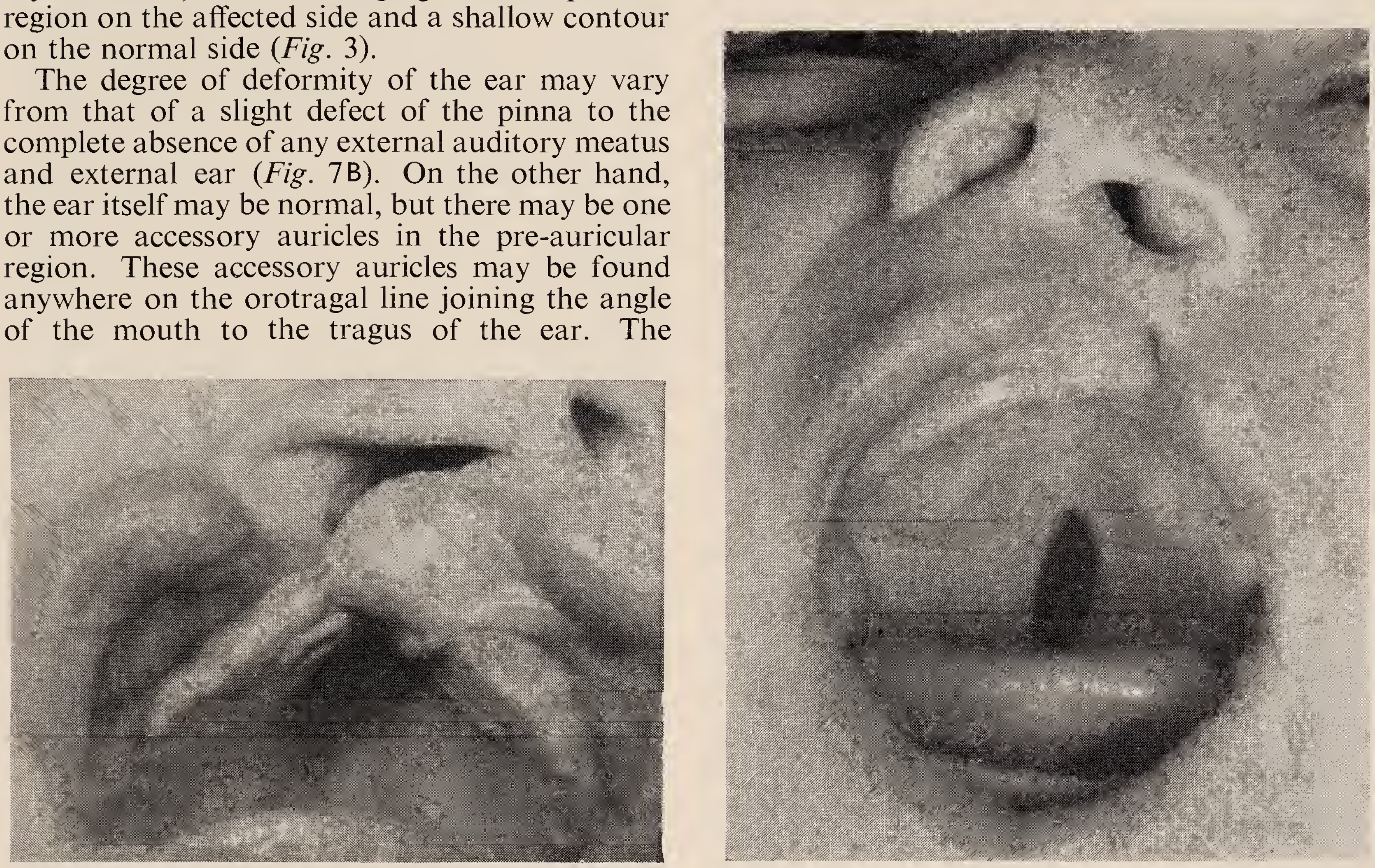
UNILATERAL AURICULOFACIAL HYPOPLASIA

As the name suggests this is a unilateral partial, or complete developmental failure of the area of the ear and the face, including the maxilla and the mandible. Any one or all of these areas may be affected to a greater or a lesser degree, resulting in severe disfigurement of the face and distortion of the craniofacial complex of bones.

The condition is unilateral, and there is a partial lack of growth of the cranium and the face on the affected side. This gives the head a twisted appearance, the sound side forming an arc of a circle with the centre situated in the region of the external auditory meatus of the

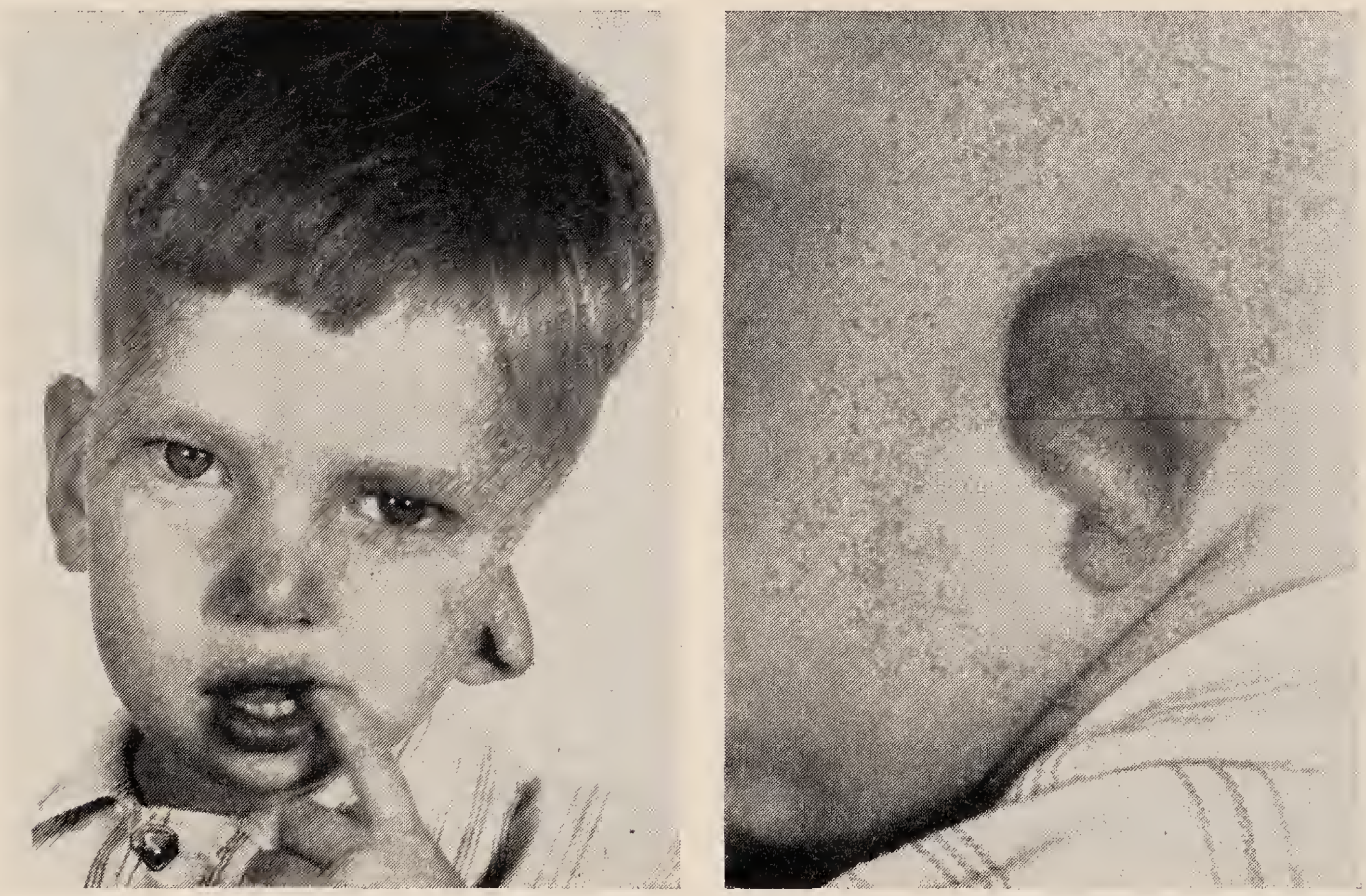
defective side (*Fig.* 7A). The greatest distortion is to be found at the extremities, i.e., the sagittal suture and the chin. The head shape itself is asymmetrical, with a bulging in the parietal region on the affected side and a shallow contour on the normal side (*Fig.* 3).

The degree of deformity of the ear may vary from that of a slight defect of the pinna to the complete absence of any external auditory meatus and external ear (*Fig.* 7B). On the other hand, the ear itself may be normal, but there may be one or more accessory auricles in the pre-auricular region. These accessory auricles may be found anywhere on the orotragal line joining the angle of the mouth to the tragus of the ear. The external auditory meatus may be completely absent or, if present, atresic, ending in a blind hole with no tympanic membrane. The inner



A B

Fig. 6.—A, Cleft of lip, alveolus, and primary palate. The hard and soft palate are intact. B, Partial cleft of lip, alveolus, and soft palate. The hard palate is intact.



A B

Fig. 7.—Auriculofacial hypoplasia. A, The left side of the face is deficient, the sound side forming an arc of a circle round the defective side. (I am grateful to Mr. F. T. Moore for permission to publish this photograph.) B, The ear is disorganized.

and middle ear are not necessarily affected, but the incus and malleus, which are first arch derivatives, are most likely to be absent. On the other hand, the stapes, being of second arch origin, is usually present. Hearing varies considerably

Fig. 8.—Development failure of the lateral nasal process; note the reduction in size of the normal side, and the ocular hypertelorism.

with the severity of the deformity, but there is usually some hearing loss on the defective side.

The degree of the defect of the mandible may vary from a slight reduction in the overall size of that half of the mandible to a complete absence of the vertical ramus including the angle of the jaw. The absence of the muscles of mastication, and of the temporomandibular joint, add considerably to the facial deformity. The maxilla is usually less affected than the mandible, being developed as a membrane bone. There is, however, usually a reduction in the size of the whole bone with an elevated occlusal plane on that side. The zygomatic arch is usually absent and the malar deficient. This is probably the main contributing factor to the reduction in the size of the orbit, and its lower position relative to the normal orbit. Occasionally the eye itself may be deformed and functionless.

The mouth is not commonly affected, but macrostomia may exist with an extension of the mouth along the orotragal line, forming a lateral cleft of varying length.

Other deformities of the lips have been recorded, especially an oblique cleft of the lower lip from the vermilion border to the mentalis muscle (Braithwaite and Watson, 1949), but the usual clefts of the upper lip and palate are not met with in conjunction with auriculofacial hypoplasia.

In mild cases the dental arches are not greatly affected. A lateral crossbite or elevated occlusal plane may occur due to lack of vertical and lateral growth but the occlusion is usually reasonable and the function is correspondingly impaired.

The teeth themselves are all present and normal in size and shape, but usually deteriorate owing to abnormal function and lack of the normal self-cleansing action. It is of interest to note that

Fig. 9.—Right-sided failure of the eye and nasal region. There is no lacrimal system. (I am grateful to Mr. P. H. Jayes for permission to publish this photograph.)

in cases where the posterior part of the mandible is missing, the teeth and alveolar bone extend distally above the area where the skeletal bone of the mandible of the horizontal ramus is absent.

The tongue in most cases seems to be unaffected although there may be some reduction in the size of that half of the tongue. The soft tissues of the face usually show a partial paresis or sagging appearance. When the facial muscles are active the upper and lower eyelids may droop while the mouth may be pulled down and towards the normal side.

In conjunction with the first arch syndrome the failure of the other facial components, namely

the frontonasal and lateral nasal processes must be included.

Figs. 8 and 9 show two such cases, in one there has been a failure to develop of one side of the nose, in the other the eye and half of the nose is affected. The features of these two cases are similar; one-half of the nose is absent while the normal nasal opening is diminutive. There is a considerable deficiency of nasal tissue. There is marked ocular hypertelorism, and the eyes are separated by a large flat nasion area. In the case where the eye is affected, there is a very small orbit which does contain a rudimentary globe. The eyelashes are disorganized. In both cases there is a complete absence of any lacrimal system on that side, with constant weeping of the defective eye.

The upper lip is intact, but shows a very wide philtrum suggesting a failure or weakness of the submucous tissue in the midline. The midline of the maxilla shows a similar V-shaped submucous cleft at the floor of the nose. This separates the apices of the central incisor teeth, while the crowns converge to the midline.

The maxilla is reasonably well developed, but defective in anteroposterior growth. This superimposed on a normal mandible, produces pseudoprognathism.

These embryonic developmental failures are probably due to a fault in the vascularization of the area concerned. This would occur between the 3rd and 6th week of intra-uterine life. Braithwaite and Watson (1949) and also McKenzie (1958), consider that it is a partial failure of the dorsal aortic system prior to the formation of the external carotid artery. During this vital period this rapidly developing area is initially supplied by the first aortic arch. It is then taken over by the stapedial artery and its branches, to be finally supplanted by the permanent external carotid artery. Further, McKenzie considers that the failure of the stapedial artery is the most likely cause of ischaemia. It may be inadequately developed to supply the differentiating tissues, or the critical timing of the stapedial atrophy and the carotid take-over may be out of phase, causing a failure in the angiogenesis of the growing tissues. That cleft of lip and palate does not occur with auriculofacial hypoplasia is of interest, although Robertson and McKenzie (1964) report a case of conjoined twins, one with a unilateral cleft lip and palate, the other with a normal face except for an accessory auricle on the same side. It must be realized that various teratogenic agents acting on the same horizon of embryonic development may produce apparently similar syndromes, but on close analysis these are quite different. Greer Walker (1961), stresses this point in his comparison of Treacher Collins syndrome and auriculofacial hypoplasia, or, as he calls it, intra-uterine necrosis, and he demonstrates quite conclusively that these two conditions are first arch defects, but are quite different in all other aspects.

In conclusion it is hoped that these cases will assist the orthodontist in recognizing some of the unilateral deformities and will encourage further interest in these unfortunate patients.

Acknowledgements

I should like to express my thanks to all members of the Staff of the Queen Victoria Hospital, East Grinstead, for their help and co-operation in collecting this material, especially the plastic and ophthalmic units and also the maxillofacial unit who have allowed me to use their material freely. For the cephalometric radiographs I am indebted to Dr. W. Campbell and his staff, and thanks are also due to Mr. G. Clemetson and his staff for the slides and photographs.

REFERENCES

Braithwaite, F., and Watson, J. (1949), *Brit. J. plast. Surg.*, **2,** 21.
Broadway, E. S. (1964), *Dent. Practit.*, **15,** 145.
Burke, P. H. (1951), *Brit. dent. J.*, **91,** 213.
— — (1957), *Ibid.*, **103,** 41.
Glass, D. F. (1962), *Dent. Practit.*, **12,** 263.
— — (1964), *Brit. J. oral Surg.*, **1,** 194.
McKenzie, J. (1958), *Arch. Dis. Childh.*, 477.
Robertson, G. S., and McKenzie, J. (1964), *Brit. J. Surg.*, **51,** 5.
Walker, D. G. (1961), *Malformations of the Face.* Edinburgh: Livingstone.
Worster-Drought, C. (1956), *J. Laryng.*, **70,** 453.

DISCUSSION

Mr. P. H. Burke, opening the discussion, said he was interested in using photographs to measure facial growth, and in order to remove any distortion he found that the camera had to be placed at least eleven feet away from the face to produce an image of sufficient accuracy for measurement. He asked if Mr. Glass had any standard procedure for his facial photographs, and if he had any particular views on it. Had he any quantitative method of measuring facial photography in order to produce information for his surgical colleagues in connexion with the treatment of such patients?

Referring to the fact that Mr. Glass had mentioned the difficulties one had in diagnosing cases of facial asymmetry as between hypoplasia and hyperplasia, he found one thing which helped in this respect was to produce two outlines. One was made from the left side of the face and a mirror-image of this side, while the second picture was produced from the right side plus a mirror-image thereof. The composite which looked right for a child of the appropriate age indicated the unaffected side.

One of the things to be learnt from such patients was that the current conception of facial growth,

which had been largely derived from the work of Brash, was by and large correct. Where there was a condyle hypoplasia the growth of the mandible had altered in the way expected.

He said it was true that recent works had suggested that there were more complexities in facial growth than previous works had said, but nevertheless the work of Brodie, Broadbent, and other research workers had given them a good basis on which to diagnose and treat their patients.

One of the most interesting things about facial asymmetry was the way in which the tissues compensated to fit across the midline. If a patient had a hemifacial hyperplasia, where all the tissues were larger and more advanced in growth on one side there was rarely a step in the midline, although it was perfectly true that the occlusion might be disorganized. He would expect to find in the case of a hemifacial hyperplasia a lateral open bite on the normal side owing to the fact that the mandible had grown excessively large on the effective side. He wondered, therefore, if, in the patient Mr. Glass showed, where there was a unilateral enlargement of the tongue, there was not also an element of abnormal bony growth in the excessively large open bite on the normal side.

Mr. D. F. Glass, in reply, said that in relation to a child with a unilateral hemi-hyperplasia it was hard to say whether the tissues were large or small. One side might have been affected by hyperplasia just as much as the tongue.

The treatment was limited in a lot of the cases. You had to adjust your orthodontic treatment to the material you had, and to the child and to the mother.

Mr. H. G. Watkin queried whether, where the tongue was rather large, it would not have been advantageous to have reduced the size of the tongue.

Mr. D. F. Glass said that it was a very good idea to take a piece out of the tongue, but the trouble was usually to persuade the parent to let you do it.

Mr. B. C. Leighton asked whether, in the case of the hemifacial hyperplasia, there was an accompanying paralysis.

With regard to lymphangioma, where there was shown a very large swelling on one side, he queried whether there was some local deformity. He did not know whether the lymphangioma dispersed spontaneously, and if so did the local deformity disappear with it.

With regard to the two twins shown, one with a cleft and the other one apparently with no cleft but some irregularity of the lateral incisor, he asked if the radiographs led Mr. Glass to suspect that there was any abnormality there.

Mr. D. F. Glass said that in regard to the hemifacial hyperplasia he thought there was a mild paralysis in those cases, but it was very hard to tell. With a real paralysis it was quite easy. The interesting thing about the coloured boy was that the 7th nerve lesion could easily have got away as being a hemifacial hyperplasia, so that they were all very involved. In some children there were muscular weaknesses which could be mistaken for hyperplasia.

Lymphangioma did not disappear, but he could say that it was twice as common in girls as in boys, and it was very disfiguring.

With regard to the twins the non-cleft child showed no alveolar deformity.

UNCOMMON MANIFESTATION OF CLEFT LIP AND PALATE

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Several classifications of clefts of the lip and palate have been put forward over the years. Two classifications which are widely used at present were both devised many years ago. They are those of Davis and Ritchie (1922) and Veau (1931). More recently Kernahan and Stark (1958) put forward a new classification based on their ideas of the pathogenesis of cleft lip and palate.

All these classifications differ to some extent in their concept of the nature of the cleft. Veau's classification deals only with clefts of the palate and alveolar process, and seems to envisage a gradation of clefts increasing in severity from a cleft of the soft palate only at one end of the scale to a cleft involving the soft palate, hard palate, and alveolar process at the other end.

Davis and Ritchie's classification divides clefts into three main groups, the first being pre-alveolar clefts, the second post-alveolar clefts, and the third alveolar clefts, it being recognized that the latter usually involve the lip and palate.

The more recent classification of Kernahan and Stark also divides clefts into three main groups, but with the main dividing point at the incisive foramen. Their classification is based on the concept that the tissue anterior to the incisive foramen, that is the premaxillary portion of the upper jaw and the medial part of the upper lip, is derived largely from the embryological primary palate, whilst the tissue posterior to the incisive foramen, that is the hard and the soft palate, is derived from the embryological secondary palate. Their first group contains clefts entirely in front of the incisive foramen, that is clefts involving the embryological primary palate. In the second group clefts are entirely behind the incisive foramen, that is in the embryological secondary palate, and in the third group clefts extend from the lip through the alveolar process into the palate. The third group clefts thus involve the embryological primary and secondary palates.

The type of cleft to which this paper will refer does not fit well into any of these classifications, unless it is regarded as a combination of two different types of cleft. It consists of a cleft of the lip and a cleft of the palate, in the same individual, with sound tissue between the anterior and posterior clefts. This type of cleft, or combination of clefts, is of interest from both the developmental and the aetiological points of view.

DEVELOPMENT OF THE FACE

There is some difference of opinion regarding the details of the early development of the face and jaws. The classic description by His (1902) suggested that the development of the face involved the fusion of various processes around the primitive mouth, following the breakdown and absorption of the ectodermal coverings of the processes where they came into contact. It was thought that a failure of fusion would result in a congenital cleft, and the usual form and position of these clefts fits in with the idea of a failure of fusion of embryonic processes.

However, in 1910 Pohlmann cast some doubt on the idea that fusion of facial processes occurs. He postulated that instead of separate processes coming together and fusing, walls of epithelium developed into which processes of mesoderm penetrated. Failure of penetration of mesoderm resulted in the breakdown of the epithelial wall at the site where the mesoderm had failed to penetrate. This view was supported by Veau (1931) who had observed bridges of epithelium across the clefts of the lip in some of his patients. The presence of these bridges seemed to fit in better with the theory of the breakdown of an epithelial wall than with the failure of fusion of separate processes.

The concept of facial development which is held by many authorities at the present time is that the processes which form the face should be considered as swellings corresponding to growth centres in the underlying tissue, rather than as separate processes which fuse. The swellings, with their corresponding depressions, are the result of proliferation of mesoderm at the various

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growth centres, which eventually fuse beneath the surface to give the normal shape of the face. A failure of mesodermal penetration can lead to ectodermal breakdown and a resulting cleft.

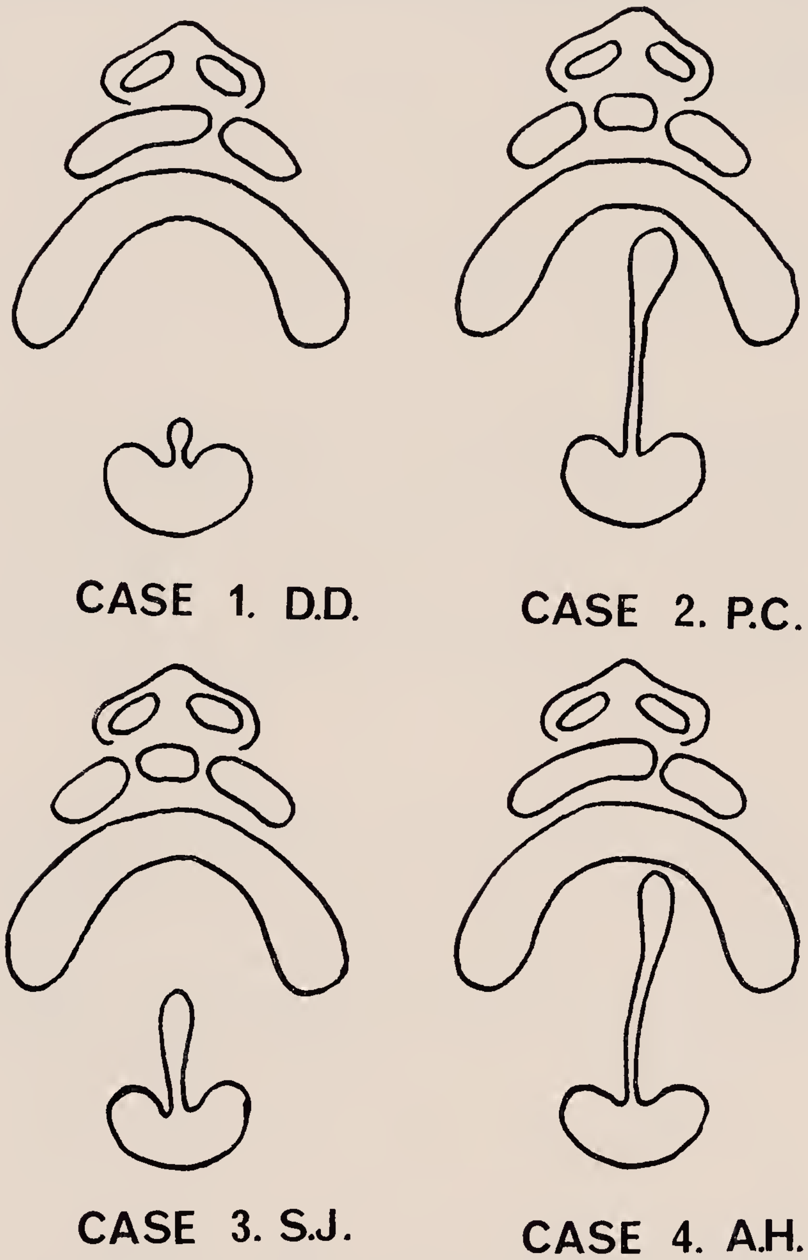

Fig. 1.—Diagrams showing the condition of the lip and palate of the four patients in *Table I*. Each patient had a cleft in front of and behind the alveolar process, the alveolar process being intact.

Formation of the upper lip and premaxilla is thought to be brought about by the penetration and fusion of mesoderm from the two maxillary processes and the primary palate. It is generally agreed that the secondary palate, later to become the hard and soft palate, forms by the fusion of two processes, or shelves, which grow medially from the maxillary processes on each side and fuse in the midline. This fusion is considered to occur first in the region where the secondary and primary palates meet and to extend backwards to the back of the soft palate (Hamilton, Boyd, and Mossman, 1962).

It can then be seen that if the modern concept of facial development is accepted, clefts which involve the primary and secondary palates represent a failure of mesodermal penetration in the anterior part and a failure of growth and/or fusion in the posterior part.

The clefts to be described here would represent an area of normal union between the anterior failure of penetration of mesoderm and the posterior failure of growth and fusion.

CASE REPORTS

Four patients are presented here, these patients exhibiting in various degrees combinations of anterior and posterior clefts with sound tissue between the clefts. All four patients have clefts of the lip and of the palate with no apparent defect of the alveolar process of the maxilla. The condition of these four patients is shown in *Table I*.

It can be seen from *Table I* that the palate cleft in these patients varies from a bifid uvula (*Case* 1) to a cleft of the whole of the soft and hard palate (*Case* 4). All the patients had lip clefts, two of them being bilateral (*Cases* 2 and 3) and the remainder unilateral clefts on the left side. None of the patients had any visible alveolar defect, but each had a rotated or misplaced incisor tooth such as is commonly associated with a cleft of the alveolar process, and two of them (*Cases* 1 and 3) had a supernumerary tooth in

Table I.—Details of Four Patients who had Clefts of the Lip and of the Palate with no Defects of the Alveolar Process

Case	Cleft Palate	Cleft Lip	Alveolar Notch	Alveolar Defect on Radiograph	Supernumerary Teeth	Rotated Teeth
1. D. D. (M)	Bifid uvula	Left	No	No	Yes, $\underline{\vert 2}$ region	$\underline{\vert 2}$
2. P. C. (M)	Soft palate and ⅔ hard palate (L)	Bilateral	No	No	No	$\underline{\vert 2}$
3. S. J. (F)	Soft palate	Bilateral	No	No	Yes, $\underline{2}$ region	$\underline{\vert 2}$
4. A. H. (M)	Soft palate and hard palate	Left	No	No	No	$\underline{\vert 1}$

the region where the cleft might have been expected to involve the alveolar process.

Fig. 1 shows diagrammatically the clefts of the lip and of the palate of these four patients. *Fig.* 2 shows the repaired lip cleft and the radiograph of the palate cleft of *Case* 2. It can be seen from the radiograph that the alveolar process appears intact.

COMPARISON WITH APPARENT COMBINED CLEFTS

In the four patients shown in *Table I* there is little doubt that the alveolar process is a bridge of intact bony tissue between the anterior and posterior clefts. Other patients are sometimes seen who have an apparent bridge of tissue behind the alveolar process, with the lip and alveolar process in front and the palate behind the bridge being cleft. Three such patients are shown in *Table II*. Careful radiographic examination of two of these three patients (*Cases* 6 and 7) suggests that in these two patients the apparent bridge does not include bony tissue and that, in contrast to the patients in *Table I*, there is, in fact, a complete bony cleft. The other patient (*Case* 5) apparently had a unilateral cleft of the lip and a notched alveolar process together with a bifid uvula. Radiographs show that there is, in fact, a bony cleft extending through the alveolar process into the hard palate, although it is not possible to determine whether the cleft extends right through the hard palate. *Fig.* 3 shows diagrammatically the apparent condition and the suspected bony clefts of the three patients in *Table II*.

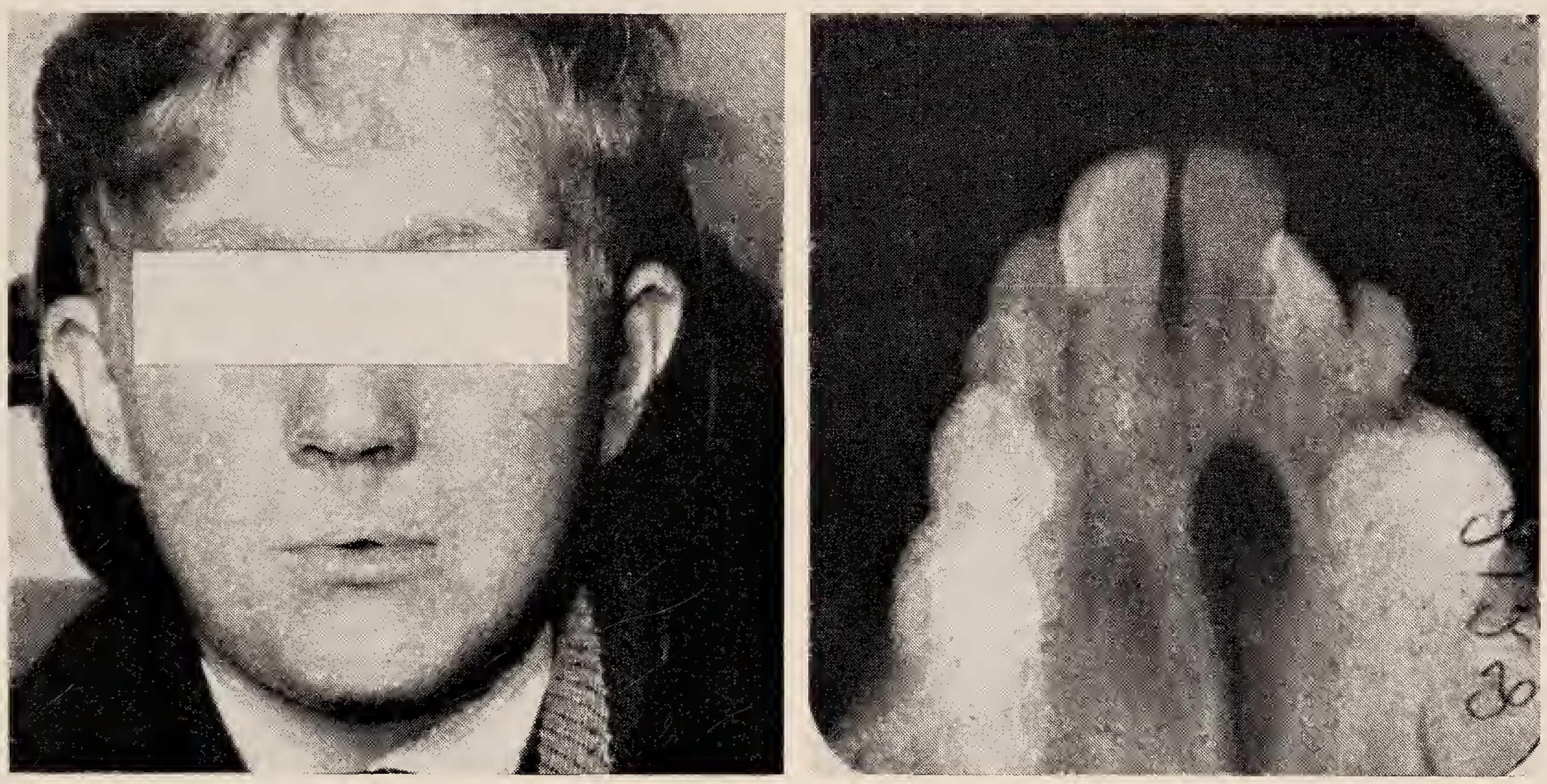

Fig. 2.—The repaired bilateral lip cleft and a radiograph showing the extent of the palate cleft in *Case* 2. It can be seen that the cleft does not extend through the alveolar process.

Table II.—Details of Three Patients who had Clefts of the Lip and Alveolar Process and of the Palate with an Apparent Bridge of Tissue between the Anterior and Posterior Clefts

Case	Cleft Palate	Cleft Lip	Alveolar Notch	Alveolar Cleft	Alveolar and Palate Defect on Radiograph
5. P. W. (M)	Bifid uvula	Left	Yes	No	Yes
6. J. F. (M)	Soft palate and $\frac{2}{3}$ hard palate	Left		Yes	Yes
7. M. P. (F)	Soft palate and $\frac{1}{3}$ hard palate	Bilateral		Yes Bilateral	Yes

One of these patients (*Case* 7), who at 21 years of age had not had her clefts repaired, appeared to have a bilateral cleft of lip and alveolar process and a cleft of hard and soft palate with sound tissue between the clefts (*Fig.* 4). This is a condition which Veau (1931) said he had never

seen and in which he exhibited considerable interest. However, although the anterior part of the hard palate appeared to be intact, radiographs suggested a continuous bony cleft through the upper jaw (*Fig*. 5).

DISCUSSION

The incidence of this combined type of cleft is difficult to assess, but it is likely to be relatively uncommon. Its occurrence is well recognized,

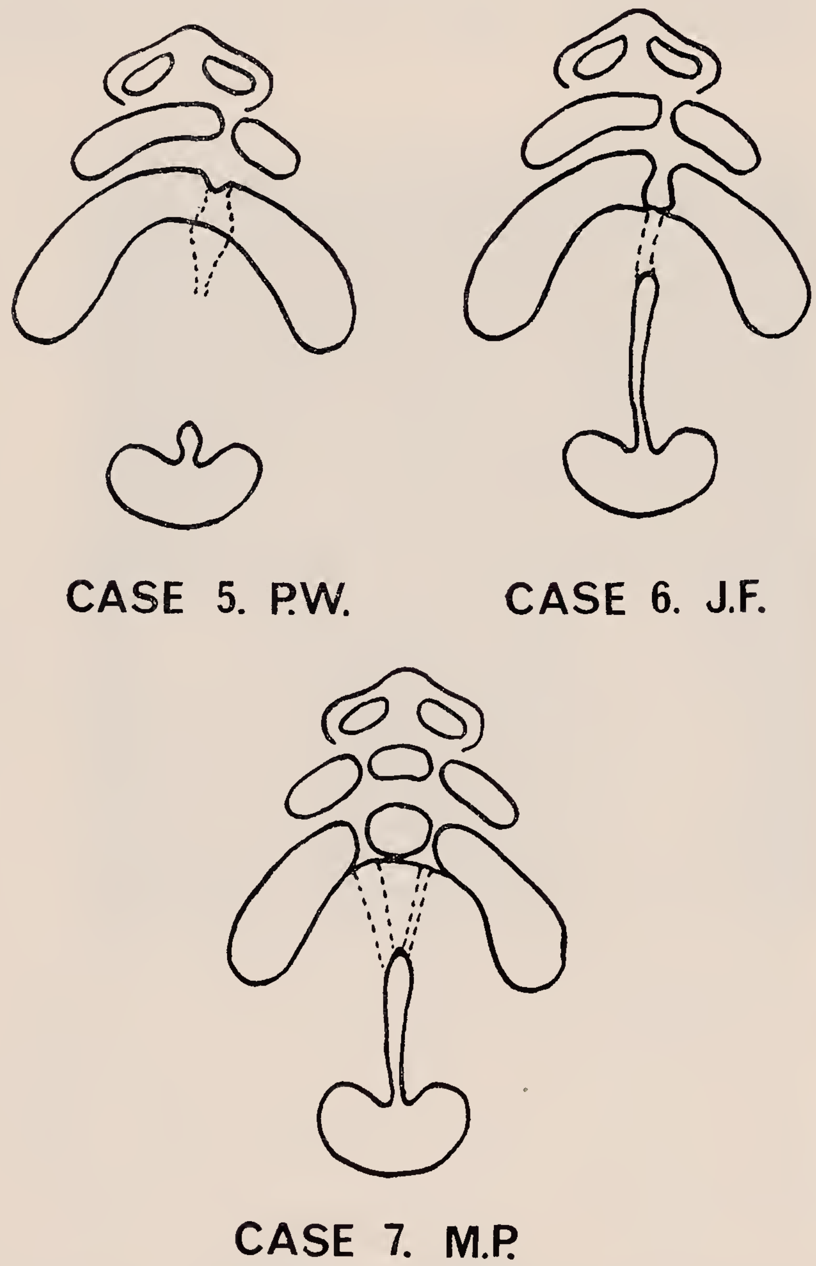

Fig. 3.—Diagrams showing the condition of the lip and palate of the three patients in *Table II*. The continuous lines represent the manifest condition and the dotted lines represent the suspected bony clefts revealed by radiography.

and it is mentioned by Veau (1931), Fogh-Andersen (1942), Davis and Ritchie (1922), and Kernahan and Stark (1958), among others. The incidence is, however, not usually quoted, but two references to it have been found. Davis and Ritchie (1922) state that approximately 4 per cent of their cleft lip and palate patients had a pre-alveolar and a post-alveolar cleft, and Veau (1931), reporting on 500 patients, shows 20 with this combined cleft in various degrees, again exactly 4 per cent.

As far as classification is concerned, the combined cleft is considered by some to be a variant of a complete cleft of lip, alveolar process, and palate, but Davis and Ritchie (1922) classify it as two separate clefts, a pre-alveolar and a post-alveolar cleft.

It is perhaps from the point of view of their aetiology that these combined clefts are the most

Fig. 4.—The lip and palate of *Case* 7, showing the apparently non-cleft area of the hard palate behind the bilateral cleft of the lip and alveolar process.

Fig. 5.—Radiograph of the palate of *Case* 7. Although clinically there was contact between the two sides of the hard palate, the radiograph reveals the cleft through the bone.

interesting. It is usually considered that clefts of the lip or of the lip and palate have a different aetiological background to clefts of the palate only. Fogh-Andersen (1942), studying the manifest condition and family history of 703 patients

with various types of cleft lip and palate, concluded that there were two different malformations with no genetic connexion, namely (1), cleft lip with or without associated cleft palate, and (2) isolated cleft palate. He thought that cleft lip, with or without cleft palate, had a mainly genetic background, whereas isolated cleft palate was often of entirely environmental origin. Burston (1958) has listed some possible causes of isolated cleft palate. These include the formation and breakdown of cysts at the line of fusion, and the failure of the tongue to descend from between the palatal shelves, as well as lack of co-ordination between growth in width of the head and the development of the palatal shelves. Fraser (1955) suggested that the genetic factors concerned in the inheritance of cleft lip, with or without cleft palate, were different from those concerned in the development of cleft palate in isolation. This view was supported by the studies of Ingalls, Taube, and Klingberg (1964) into the family histories of 100 children with various types of cleft lip and palate.

However, Rank and Thomson (1960), after studying the family histories of 221 patients with cleft lip and palate in Tasmania, concluded that, contrary to the view of Fogh-Andersen, cleft lip with or without cleft palate is not always caused by a different genetic system from that producing isolated cleft palate. They suggested that isolated cleft palate may sometimes be a partial manifestation of the cleft lip and palate malformation and not a separate entity. Furthermore, they found several instances where cleft lip and palate and isolated cleft palate occurred in the same family.

This leads to two possibilities regarding the aetiology of the combined clefts of the lip and of the palate occurring in the same patient. The first is that it is a partial manifestation of a complete cleft through lip, alveolar process, and palate. As mentioned before, it is thought that fusion of the palatal shelves occurs first in the region where the secondary palate and primary palate meet, and extends backwards from there. These combined clefts could be the result of partial fusion of the palatal shelves and incomplete penetration of mesoderm from the maxillary process as a combined manifestation of one condition. The second possibility is that the combined cleft represents two separate clefts of different aetiology occurring in the same patient. The former explanation is the one which is most usually accepted, but the latter one cannot be ignored. It is perhaps unfortunate that the relative rarity of these combined clefts makes family history studies difficult. Of the patients presented here, none had any definite family history of clefts of the lip or palate.

Finally, it is interesting to note that of the four patients who had no apparent alveolar process defect at all, all had a rotated or misplaced incisor tooth, two had supernumerary teeth, and one had a diminutive lateral incisor. These dental anomalies are, of course, well known to occur in association with a cleft of the lip, even when the alveolar process is intact, and their appearance in these four patients does not obviate the possibility that two distinct and aetiologically separate clefts are present in some or all of these patients.

REFERENCES

Burston, W. R. (1958), *Trans. Brit. Soc. Orthodont.*, 41.

Davis, J. S., and Ritchie, H. B. (1922), *J. Amer. med. Ass.*, **2,** 1323.

Fogh-Andersen, P. (1942), *Inheritance of Harelip and Cleft Palate.* Copenhagen: Busck.

Fraser, F. C. (1955), *Acta genet.*, **5,** 358.

Hamilton, W. J., Boyd, J. D., and Mossman, H. W. (1962), *Human Embryology.* 3rd ed. Cambridge: Heffer.

His, W. (1902), *Abh. sachs. Ges. (Akad) Wiss. Math. phys.*, **27,** 349.

Ingalls, T. H., Taube, I. E., and Klingberg, M. A. (1964), *Plast. reconstr. Surg.*, **34,** 1.

Kernahan, D. A., and Stark, R. B. (1958), *Ibid.*, **22,** 435.

Pohlmann, E. H. (1910), *Die embryonale Metamorphose der Physiognomie und der Mundhohle des Katzenkopfes.* Leipzig: Dissertation.

Rank, B. K., and Thomson, J. A. (1960), *Med. J. Aust.*, **47,** 681.

Veau, V. (1931), *Division Palatine.* Paris: Masson.

DISCUSSION

Professor D. P. Walther said that Mr. Foster quoted 4 per cent for the incidence of subtotal clefts, and that was about the same as they had found at the Hospital for Sick Children in Great Ormond Street. It was interesting that on examination of the first 100 cases it was found to be about 6 per cent, but this gradually settled down to 4 per cent when they reached about the 400 mark.

The more he examined such cases he came to the conclusion that they were a variant of the cleft lip, with or without palatal involvement. He thought he was correct in saying that most geneticists at the moment were revising their opinions as to the true significance of genetic background. He always felt that a cleft of the palate only had an entirely different genetic background from that of a cleft lip with or without a cleft palate.

Mr. Foster did not find a single case in which the cleft lip was on the right side, and that was also their finding at Great Ormond Street. He had, however, found one case at the Royal Dental Hospital in which the cleft was on the right side, although there was some doubt whether the bridge of bone was intact in that case.

He also noticed that five out of the six cases were males and this distribution was in keeping with

Anderson's finding that the cleft lip with or without cleft palate was more common in boys than in girls.

He had never seen a typical micrognathic case in which the lip was also involved, and he would be interested to know if Mr. Foster had.

Mr. D. F. Glass said that the last bilateral cleft shown was in a 21-year-old, and she would not have had collapse of the upper buccal segments if she had had a proper union of the area concerned. Clefts of that type were only obvious when you opened up for surgery and to look at a radiograph was very, very, dangerous indeed in coming to a decision of that kind.

The fascinating pictures of the lateral incisors and the extra incisors he thought were very good, because although there appeared to be nothing wrong in the area it showed the incisors to be chaotic.

He did not understand this association of the isolated palate with the cleft lip and palate. All the cases Mr. Foster showed were obviously associated with the cleft lip and palate. He thought he was right in saying that all these clefts were V-shaped, whereas with the isolated palate they were nearly always U-shaped. That was why the speech problem was so different.

Mr. A. G. Huddart said that he was particularly interested in the seventh case by the narrowness of the upper arch. He always thought that in that pattern of case the arches were pulled apart because there was no functional muscle. He would be interested to have Mr. Foster's comments on whether on operation it would narrow further or whether it would stay where it was.

He also noticed on the same slide, up in the cleft area, a large bright-red mass, and he wondered whether that was adenoids or perhaps something more peculiar.

Dr. P. H. Démogé asked if Mr. Foster thought the continuity of the alveolar process in the cases he had shown allowed a better prognosis for alinement of the incisors than would be possible in cases where the cleft was a total cleft.

Mr. T. D. Foster, in reply, said that he had not seen a true micrognathic in any of the combined clefts. He had seen a patient with a complete unilateral cleft through the lip, alveolar process, and palate, with a very small lower jaw—a very marked Class II case, which was somewhat unusual—but she had never been assessed as a true micrognathic.

He found Mr. Glass's comments very interesting with regard to the patient shown last, the unoperated girl. He thought there was a complete cleft in this patient, but in fact he was still looking at her and he hoped to find out more about her.

Mr. Huddart's comment regarding the narrowing of the arch was also a point in favour of suggesting that this patient had, in fact, a complete cleft.

He agreed with Dr. Démogé's remark that if there was an apparent continuity of the alveolar process it seemed to allow alinement of the teeth rather better than if there was a definite cleft.

SYMPOSIUM ON MULTIBAND APPLIANCES

I. THE TWIN-WIRE ARCH

J. S. BERESFORD, B.D.S., F.D.S., D.Orth. R.C.S.

Consultant Dental Surgeon, The London Hospital

To BE asked to read a paper to this Society is an honour and to do so under the presidency of Mr. Walpole Day gives me the greatest pleasure for during the years when I was your treasurer I became much indebted to Mr. Day for his constant readiness to help with the financial problems of the Society. In particular I found him a valued ally when it was decided to move some of your capital from gilt-edged securities into equities. I am indeed grateful, and I am sure all of you are too, for the guidance he was able to give the Council at that time.

Of all the multiband appliances the twin-wire arch is perhaps the easiest to use. Not quite so many teeth have to be banded as in most of the other techniques and it is not necessary to bend up arch wires individually for the patient. It is true that those who use the appliance regularly carry a stock of about half a dozen preformed arches in at least twenty-four different sizes, but once the stock has been built up it is easily maintained by the dental chairside assistant.

The impetus to the use of the twin-wire appliance in this country was given by Townend (1946). In 1947, as a very new member of the Society, I gave a demonstration. Mills (1959) read a valuable paper at the Country Meeting in Manchester. It is assumed that you all have some knowledge of the appliance. The principles underlying its use, and the details of its construction, are admirably set out in the writings of Johnson (1941), Dolce (1943), Barber (1943), Eby (1943), Porter (1943), and Madden (1943, 1947, and 1948).

The twin-wire arch appliance can be used in the treatment of all three of Angle's classes of malocclusion, which is true of a good many appliances. I would like to draw your attention to one or two details regarding the use of this appliance. These are well described in the literature, but their importance is not always appreciated until a certain experience has been gained. I will also try to point out the kinds of tooth movement which the appliance does best and one movement which, in my opinion, the appliance scarcely does at all. Although the twin-wire arch is a very good appliance it is not necessarily the first choice in every malocclusion. Sociological considerations, as well as dental considerations, affect the choice of an orthodontic appliance.

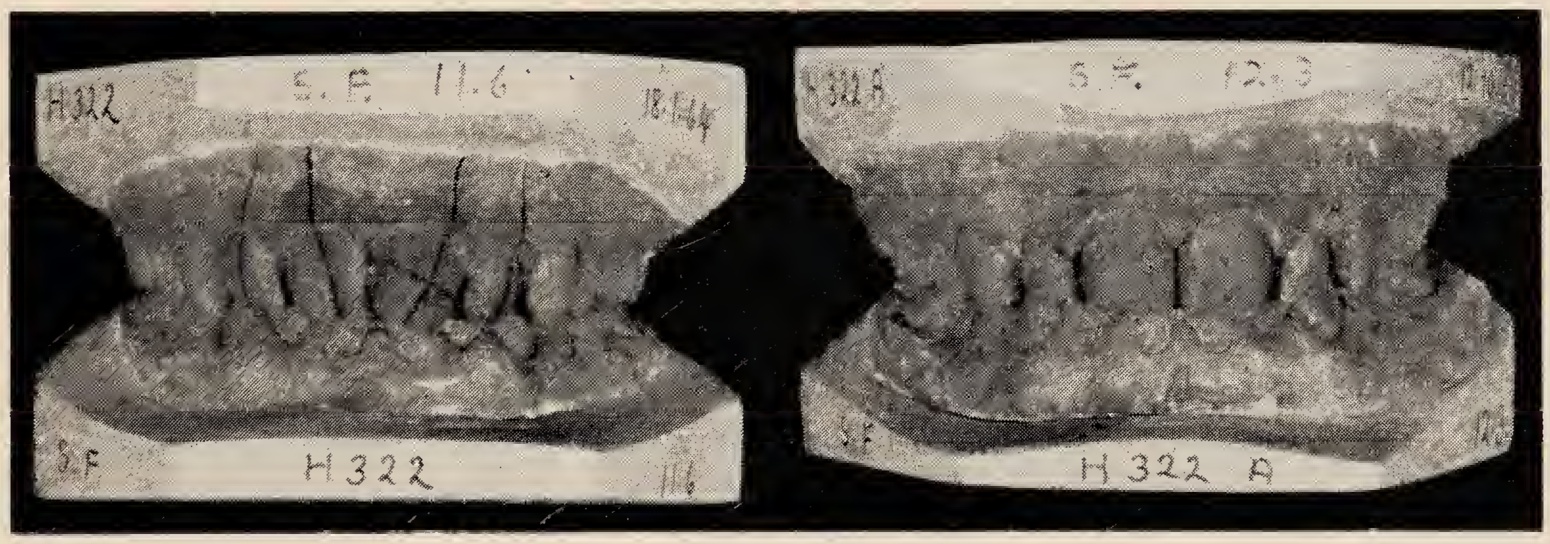

Fig. 1.—Before and after models showing tipped and rotated teeth which were corrected by an upper twin-wire appliance and lower lingual arch with intermaxillary traction.

Rotations and mesiodistal tipping are corrected easily, really automatically, by the twin-wire arch (*Fig.* 1). Distortion of the twin wires vertically and horizontally is, of course, routine when

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the appliance is first fitted, so as to reduce the corrective force applied to all malposed teeth. Bends, and particularly step bends, in both vertical and horizontal planes are used again in the final stages to over-correct rotated and tipped teeth. Rotations should be over-corrected by step bends in the horizontal plane introduced late in treatment, or by the accessory band attachments described by Mills (1959). Mesiodistal

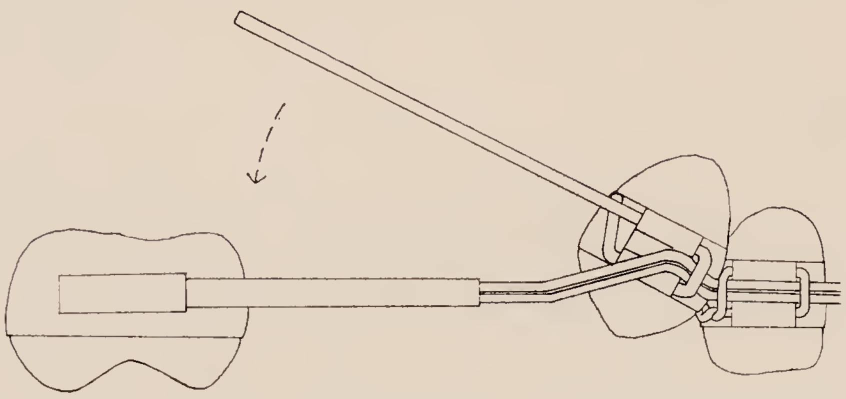

Fig. 2.—An adjunctive spring, or lever, the free end of which is ligated to the end-tube to facilitate the uprighting of the canine.

tipping is facilitated by step bends in the vertical plane or by the use of an adjunctive lever or spring with its fixed end in the ripple bracket. The free end stands above the end-tube and is then ligated down to it (*Fig.* 2).

In moving upper anterior teeth forward in a mild Class III malocclusion the twin-wire arch will tip them less than would finger springs and the appliance can be adjusted downward to guard against loss of overbite.

The twin-wire arch will not, however, tip the apices appreciably forward, nor for that matter will it tip them palatally. Because the twin wires fit tightly into the brackets, when caps or ligatures are used, and because the double arch in section is not round it might be thought possible to move anterior teeth bodily labially or lingually.

In fact, this is not so (*Fig.* 3). No doubt the degree of tip is less than if the same tooth movement were attempted with a finger spring from a labial or lingual arch wire, but the tooth movement is still far from bodily movement. The reason, presumably, is that the twin wires can roll over one another in the small sections between the brackets; that is between the teeth, and also between the anterior part of the end-tube and the distal of the first bracket. This is quite different from the behaviour of a single rectangular wire, as in the edgewise appliance, with rectangular brackets and rectangular buccal tubes.

In treating a Class II malocclusion of either division it sometimes is desirable to move the upper incisor root apices palatally so as to improve the angle between the upper and lower incisors. The twin-wire arch will not effect such a tooth movement.

A fixed appliance is probably the most effective appliance in treating a Class II, division 1 malocclusion, unless the child is far away at school. In Class I as well as in Class II malocclusions intermaxillary or occipital traction must be used with the twin-wire appliance, as otherwise the upper anterior teeth will move forward. If the twin-wire appliance is fitted to the upper arch first, so as to get on with the correction of any rotations, there is a great temptation to postpone too long the banding of

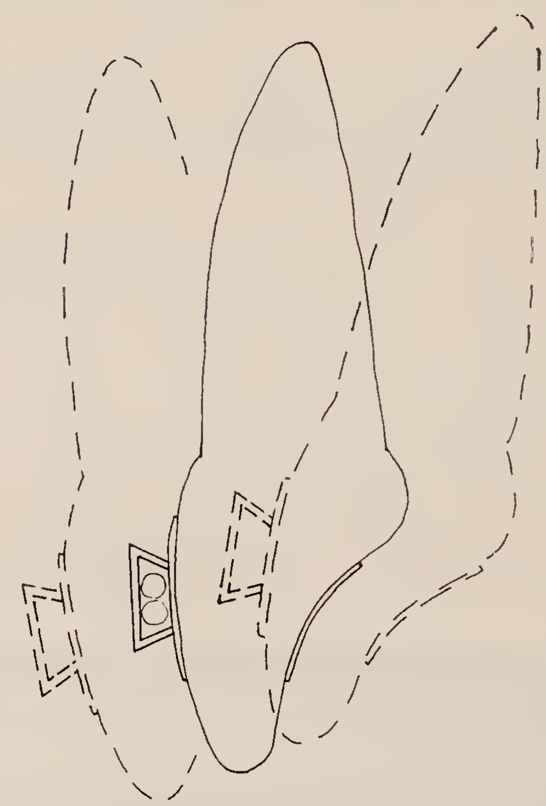

Fig. 3.—The apical movement envisaged by the broken lines, although sometimes desirable, is not in fact possible with the twin-wire arch.

the lower teeth. Therefore my advice is to start in the lower arch and not to cement a solitary upper band until a lower appliance to receive intermaxillary traction has been cemented. This might be a lower lingual arch, a lower lingual arch with a labial sectional arch to reduce the risk of forward tipping of the lower teeth, or a lower labial appliance. The lower labial appliance is especially suitable when there have been lower extractions and where some forward movement of the first or second molars, under the pull of the elastics, is desirable (*Fig.* 4).

While a perfectly straight end-tube is an asset it is more important to attach the buccal tubes permanently to the molar bands. As I am one of those who distrust intra-oral soldered joints in stainless steel this means welding. Accordingly, it is sometimes necessary to bend the end-tubes. This is all right, but the most posterior bend, in Class I and Class II treatments, must obviously be several millimetres in front of the buccal tubes. The first twin-wire arch is inserted without intermaxillary hooks, but these are added when the arch is renewed at the second visit. That is, elastic intermaxillary traction is initiated virtually at the outset. The correction of rotated or tipped anterior teeth and/or mesiodistal drifting is performed while the overjet is being reduced. The introduction of intermaxillary traction is only

delayed when one or more of the anterior teeth is really badly misplaced.

When treatment is progressing smoothly, and the overjet is partly reduced, it is sometimes possible to change to single round labial arch wires, using 0·7-mm. wire in the upper and probably 0·5-mm. wire in the lower. Assuming may be added to the end-tubes of the twin arch or the buccal segments of the small round arch. The anterior ends of the springs are better attached to the arch itself, e.g., to traction hooks or traction loops, than to the canine brackets unless a space is desired between the canines and the lateral incisors. When coil-springs are used

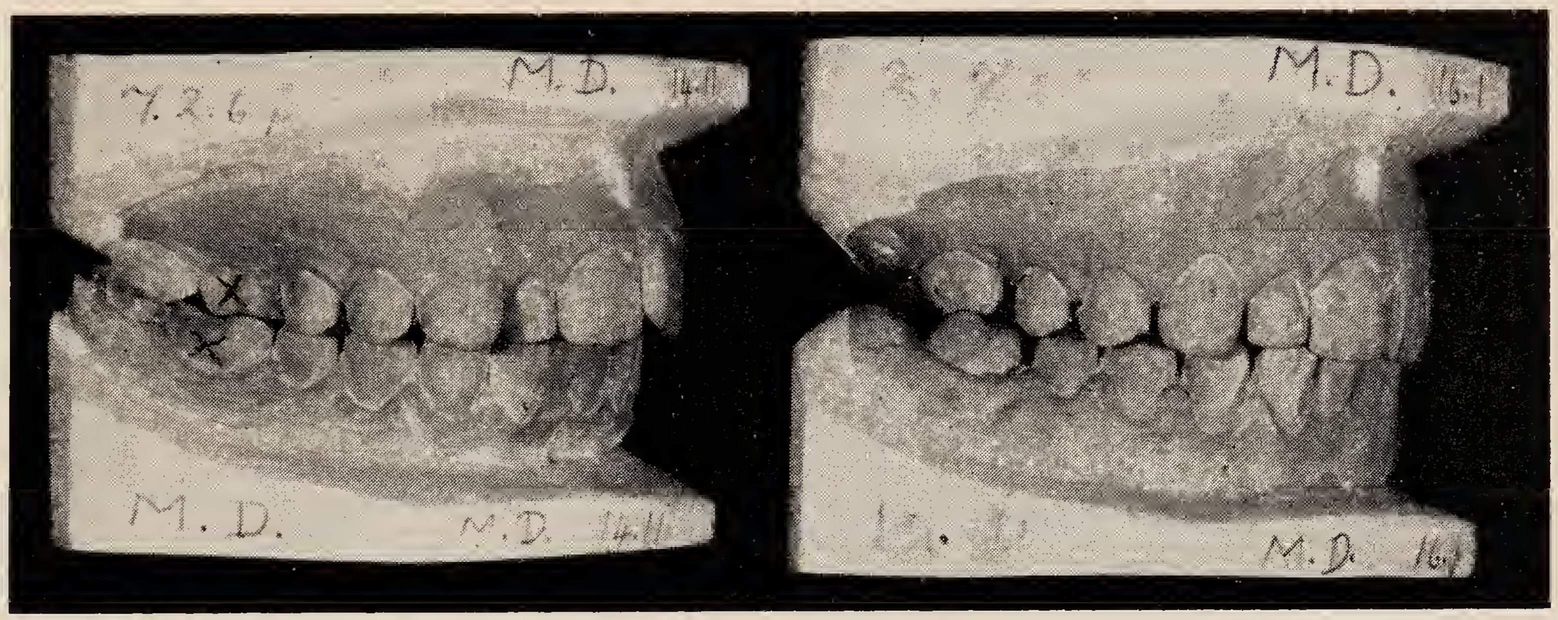

Fig. 4.—Second molars moved forward as a part of treatment with upper and lower twin-wire arches and intermaxillary traction.

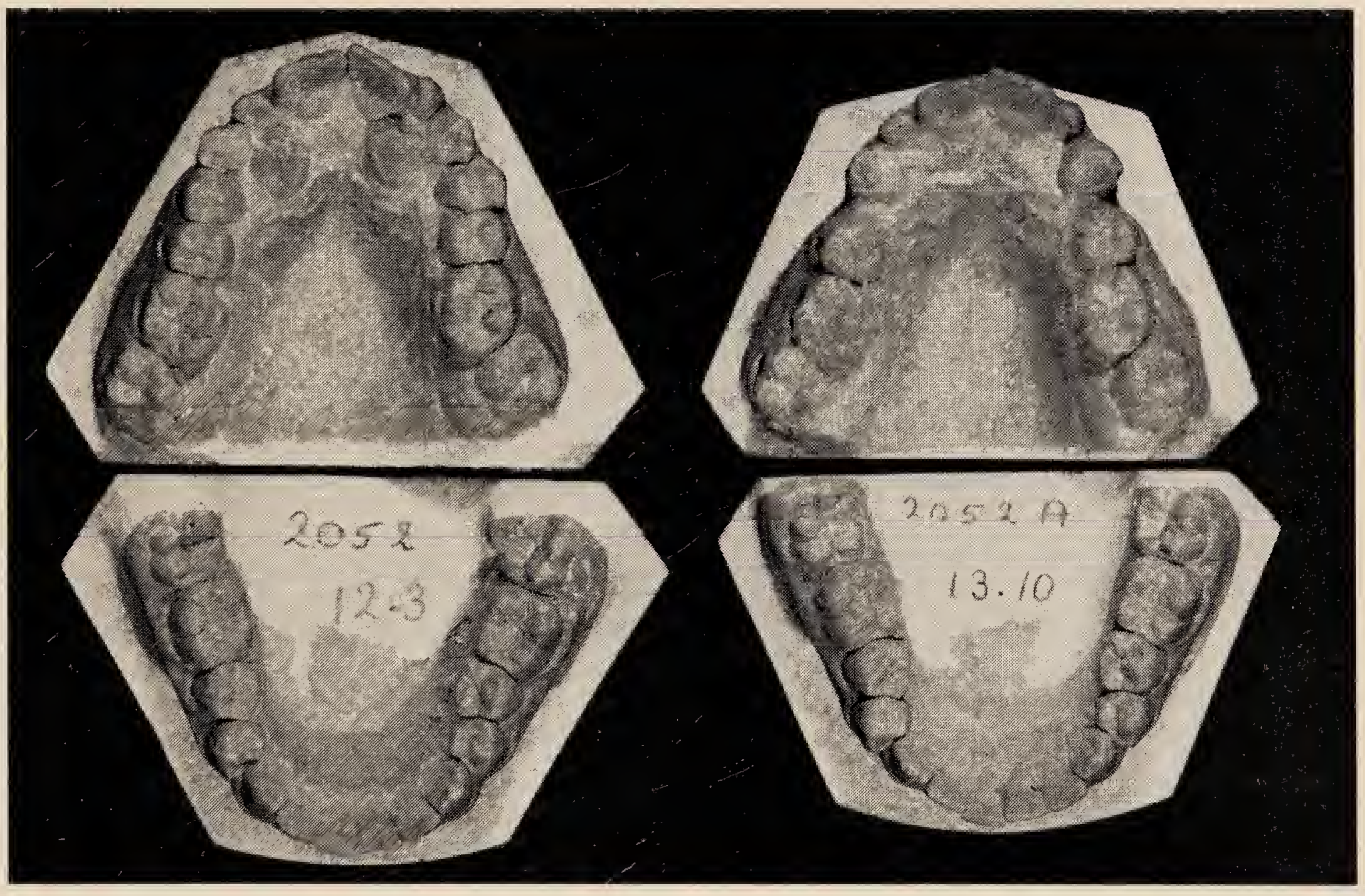

Fig. 5.—The misplaced upper canines erupted subsequent to oral surgery and were moved into the line of the arch by a palatal arch wire with finger springs. They were then uprighted and rotated by a (labial) twin-wire arch.

that lower molars are being drawn forward along the labial arch wire by elastics, the smaller gauge wire allows one to introduce corrective bends to keep the molar crowns more nearly upright.

If other aspects of the treatment are proceeding more rapidly than the forward movement of the lower molars, coil springs, under tension, alone, that is, not as an adjunct to intermaxillary traction, it is a worth-while precaution to see the patient a little more frequently so as to be certain that the right teeth move.

When a heavier, inert, upper labial arch wire is introduced it is sufficient to ligate it to the lateral incisor brackets so that the central incisor

and canine bands can be removed. I hesitate to make this change when the arches are narrow or there has been very much uprighting or rotating of teeth.

With the assistance of the oral surgeons a misplaced canine may be encouraged to erupt into the palate (*Fig.* 5). It can often be moved readily into the line of the arch by a finger spring from a Mershon lingual arch wire, preferably in precious metal. This appliance is unseen, and the parents may be very impressed by the tooth movement it effects. It is most important to have explained to them at the outset that when this stage is reached a change will be made to a multiband labial appliance to complete the positioning of the canine. The canine itself may need a cast silver cap, until it has been moved into a position where a conventional band and bracket can be fitted. The labial appliance is needed for only a few months, but what a difference it makes!

The alternative is to risk being left with the canine in the line of the arch, but still rotated, tipped, and/or ' under erupted ' by two or three millimetres. The patient may be 18 years of age, refusing anterior bands, and the patient and parents fast lose confidence in the orthodontist because he is unable to complete treatment with invisible or night-time appliances.

The twin-wire arch is the most useful appliance in the treatment of grossly malposed anterior teeth, perhaps associated with delayed eruption, or an alveolar cleft.

In the initial stages of moving a malposed incisor from high in the sulcus down to the level of its fellows, the classic method is to take only one of the twin wires up to the malposed tooth. I prefer to distort both twin wires vertically towards the malposed tooth and/or to use a long ligature.

Acknowledgements

My grateful thanks are due to Mr. P. B. Broadbury and Mr. A. L. Kirk, of the London Hospital, and to the medical division of Messrs. Kodak for helping me to assemble photographic equipment suitable for use in my own consulting room, and for their invaluable advice whenever I encountered difficulty with the technique of intra-oral colour photography.

REFERENCES

Barber, H. U., jun. (1943), *Amer. J. Orthodont.*, **29**, 340.
Beresford, J. S. (1947), *Trans. Brit. Soc. Orthodont.*, 97.
Dolce, J. J. (1943), *Amer. J. Orthodont.*, **29**, 338.
Eby, J. D. (1943), *Ibid.*, **29**, 344.
Johnson, J. E. (1941), *Ibid.*, **27**, 202, 289, 347.
Madden, C. K. (1943), *Ibid.*, **29**, 355.
— — (1947), *Ibid.*, **33**, 420, 442.
— — (1948), *Trans. europ. orthod. Soc.*, 88.
Mills, J. R. E. (1959), *Trans. Brit. Soc. Orthodont.*, 34.
Porter, L. J. (1943), *Amer. J. Orthodont.*, **29**, 348.
Townend, B. R. (1946), *Dent. Rec.*, **66**, 1.

II. REPORT ON THE LIGHT-WIRE TECHNIQUE

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The so-called ' light-forces ' technique of orthodontic treatment owes a great deal to Dr. P. R. Begg of Australia, who, for many years, used this method and perfected it (Begg, 1954, 1956, 1961). It is a complete theory of orthodontic practice, since all malocclusions can be treated with very satisfactory results. In recent years, North American as well as European orthodontists have been studying this method and have set up courses for its teaching. In the United States, two centres are particularly active in Illinois and in Indiana, and on this side of the ocean, in the Netherlands. As should be expected, differences have arisen between teaching teams, This report will reflect basically the teaching of the Kesling-Rocke Group, as given at the University of Indiana, and described in the book recently published by Begg (1965) in association with this group.

Thanks to Dr. Kesling's help, photographs of a completed case will be shown and I wish to acknowledge his extreme kindness in letting me have such excellent documents for our benefit. Close inspection of many treated cases at the Orthodontic Center in Westville, Indiana, has convinced me that results stand up to the most exacting requirements and compare favourably with those of other great masters of our speciality.

GENERAL TREATMENT PROCEDURES

The technique requires banding of all teeth present in the mouth, with the exception of second molars, when first molars are not extracted. This point is important, since reciprocal forces give their best results when all teeth can be called upon at various stages of the treatment. This can only be achieved in a simple

manner when all teeth carry bands of the same design. In most cases, although treatment may aim at changes in one arch only, it is of advantage at some stage of the treatment to be able to call upon the antagonist dental arch for support of forces, to control, for example, movements such as lingual or buccal ‘ rolling ’ of molar or premolar teeth.

According to this method, all bands are equipped with special brackets, except molar bands which carry round end-tubes of 0·036 in. (roughly 0·9 mm.). It is extremely important to use brackets with vertical channels without which control of axial inclination of the roots is most difficult—if not impossible to achieve when using round arch wires. The brackets should allow free sliding of a 0·016 in. (0·4 mm.) wire. The vertical channels will receive locking pins, ligature wires, and uprighting springs. The slots, besides the main arch, will also receive in Stage III auxiliary wires of different types, to give lingual root torquing of incisors. Use of horizontal slots such as the twin-wire, or the edgewise technique brackets does not allow control of root inclination in the mesiodistal direction with round wires, although the latter of course will, with the heavier edgewise rectangular wire. What is more, they do not allow simple tipping of the crowns.

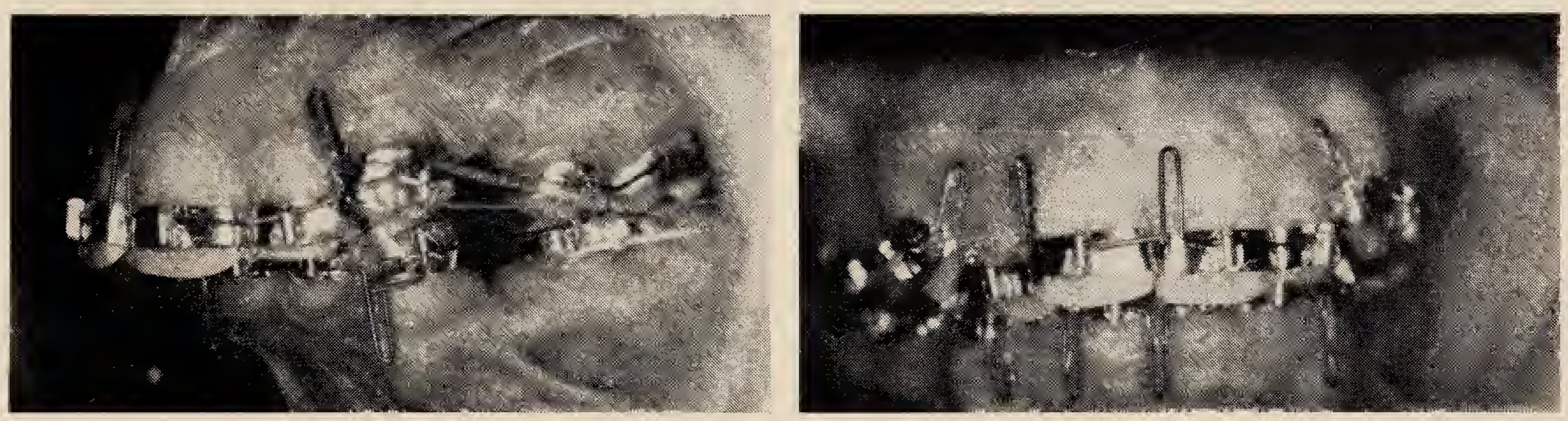
All molars and premolars as well as canine teeth are equipped with lingual buttons, which will be very useful at different stages of the treatment.

Actual Forces involved in the Procedures

These forces are of three kinds:—

1. The highly tensile wire developed by Mr. Wilcock in Australia. Even in small diameter it keeps its spring for a very long time without breaking too easily. Other makes exist that allow the same use to be made of the wires, but the importance of the high quality of the steel cannot be over-emphasized. Attempts to achieve the same results with less tensile wires are very disappointing because of the deformations that are imposed upon them by the forces of mastication and use of intermaxillary, or intramaxillary elastic forces. These qualities are just as necessary for the steel from which uprighting springs are made.

2. The shape given to the round wire arches: These will include vertical loops to isolate horizontal segments for one tooth, or a small group of teeth. The longer the amount of wire on each side of the segment, the gentler, the longer, and the better will be the action of the wire on the teeth. It will be noted, nevertheless, that these vertical loops are not very many and all have a most simple design; more loops than necessary will make the arch wire more difficult to control and to shape properly, and will add a great many breaking points, finally causing loss of anchorage in the molar area.



A B

Fig. 1.—Stage I. A, Lateral view. Intermaxillary rubber bands are used right at the beginning, and anchor bends in the wire are apparent between the second premolar and first molar. B, Anterior view. Note vertical channel-brackets on the bands and the vertical loops bent in the arch wire.

Other deformations that are included in arch wires are anchorage bends in the molar area. These, if sufficient to make the wire lie in the buccovestibular fold in the incisal area, will provide an intrusive force for incisors and canines as well as excellent anchorage to the molars. This is why extra-oral anchorage is never used in association with this method. Too much will tend to rotate the molars, too little will not depress the incisors and allow mesial drift of the molars.

3. Finally, well-calibrated, very light elastic rubber bands in large quantities will be used (throughout the whole treatment period if necessary) to correct dental base relationship (anteroposteriorly), close extraction spaces during Stage II, close interincisal diastemas where they exist, control lateral cross bites and anterior or lateral open bites. These are used to develop forces of 60 to 70 g. and should be available in various degrees of thickness and length in order to meet the different needs that may arise during treatment procedures.

STAGES OF TREATMENT

Whatever the type of malocclusion, treatment is conducted along the same basic pattern as described by Begg. There will be, of course, variations in the amount of time devoted to one stage or the other according to the case.

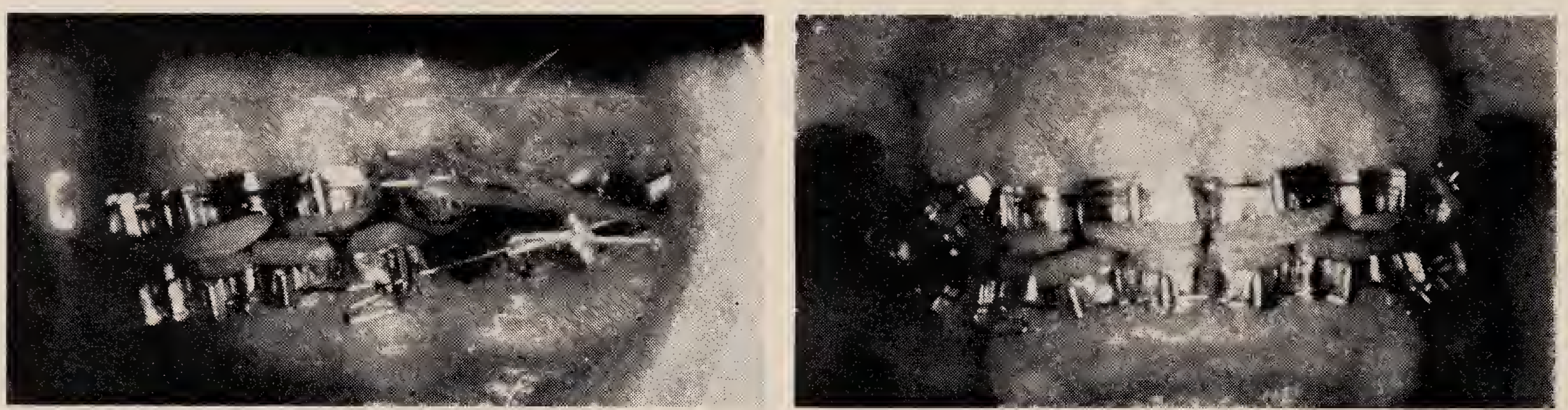


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Fig. 2.—End of Stage I. A, Anteroposterior dental relationship is normal. Rotation of mandibular second premolar is being reduced with elastic thread. This tooth is by-passed by the arch wire, to which it is lightly ligated. B, Incisal overbite has been completely treated, alinement of the anterior areas is completed.

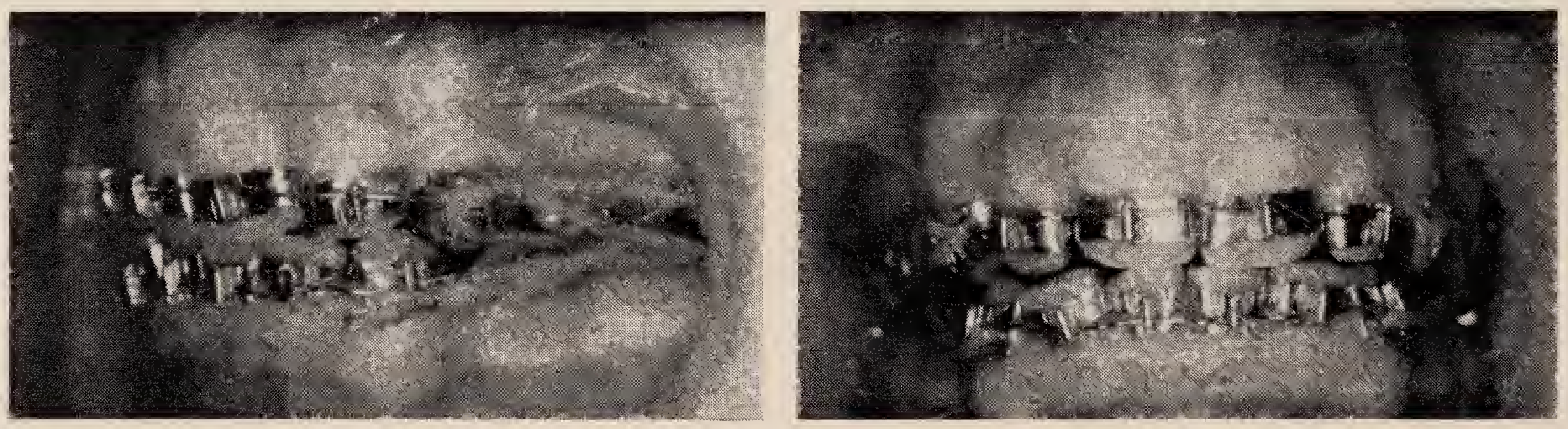

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Fig. 3.—Stage II. A, Residual spaces between canines and second premolars are being completely closed by the use of monomaxillary elastic forces. Class II traction is being maintained. B, Opening of the bite has continued a little further.

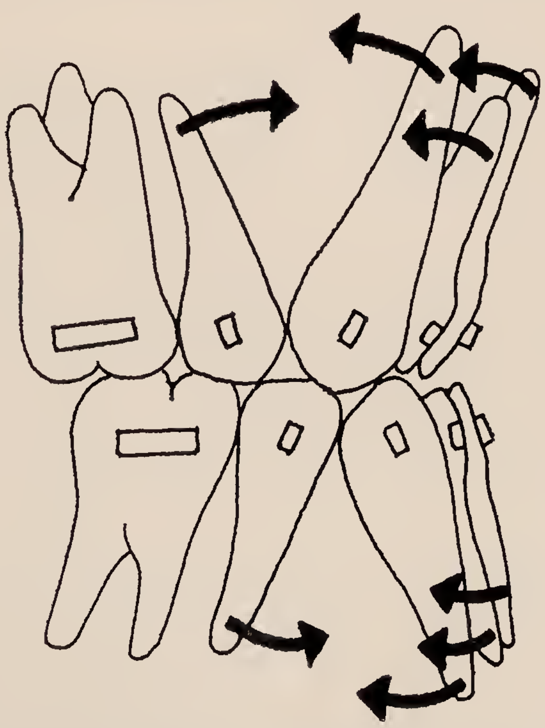

Fig. 4.—Schematic representation of the effect of auxiliary torquing arches and uprighting springs during Stage III.

Stage I

In this first stage of the treatment, all teeth have already been banded and its objective is to eliminate all individual malpositions and to reduce overbite in the incisal area while bringing the incisal edges of upper and lower incisors in an edge-to-edge relationship. This, of course, requires reduction of anteroposterior discrepancies with intermaxillary rubber bands (*Fig.* 1A). It is at this time that vertical loops are included in arch wires to eliminate individual malpositions and rotations (*Fig.* 1B). It will be noted that a minimum of vertical, or expansion loops as they are sometimes called, are used and that they always have a simple design. It is felt that the use of 0·016-in. wire of very good quality gives enough elasticity to allow favourable movement of teeth without the very elaborate designs of loops sometimes advocated by other authors. If the amount of movement necessary to bring one tooth into alinement is too much to allow bracket engagement at the first insertion, a loose ligature can be used until sufficient movement of the tooth will allow the wire to be firmly engaged in the bracket slot. During the whole of Stage I, only incisor and canine brackets are tied to the arch, the premolars being by-passed by the arch wire to which they are loosely tied (*Fig.* 1A).

The only type of movement required from the teeth is the free sliding of the dental crowns along the arch wires, with as little as possible or no movement of the apices. Since there is very little binding in the loose-fitting molar tubes and vertical slots of the brackets, the teeth can move easily, and very light forces will have a maximum of efficiency. In most cases incisors and canines will move distally along the arch wire to achieve alinement, while they are depressed in their sockets if bite-opening is required. At the same time maxillary incisors are tipped lingually if Class II intermaxillary elastics are used (*Fig.* 2A). During the whole of Stage I, anchor-bends have been used on the molars to avoid any degree of mesial drifting of these teeth under the influence of reciprocal forces. This is one of the very surprising features of the use of light forces, that molars can be kept in place by simple bends of 30° in the wire, without adjunction or actual tipping of molar-premolar segments, or use of extra-oral anchorage such as head-caps or neck-straps.

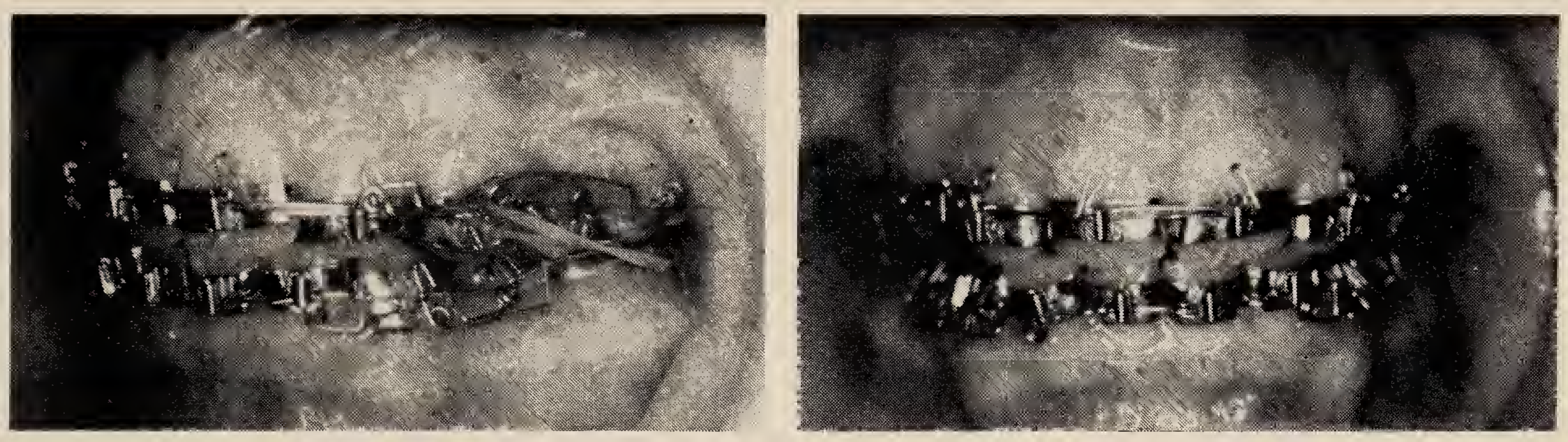

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Fig. 5.—Stage III. A, Canines and premolars carrying uprighting springs to parallel their roots, thus correcting the tipping of the crowns that occurred during Stage II. Note the palatal tipping of the central incisors, typical of the end of Stage II. B, Auxiliary arch wire extending on each side to the canine-second premolar space (which has been closed during Stage II by tipping of the crowns). This puts pressure on the cervical of the four incisors, which have been palatally tipped, thus applying a torquing force. The mandibular incisors do not require such torquing, but the mandibular lateral incisors carry uprighting springs to parallel their roots.

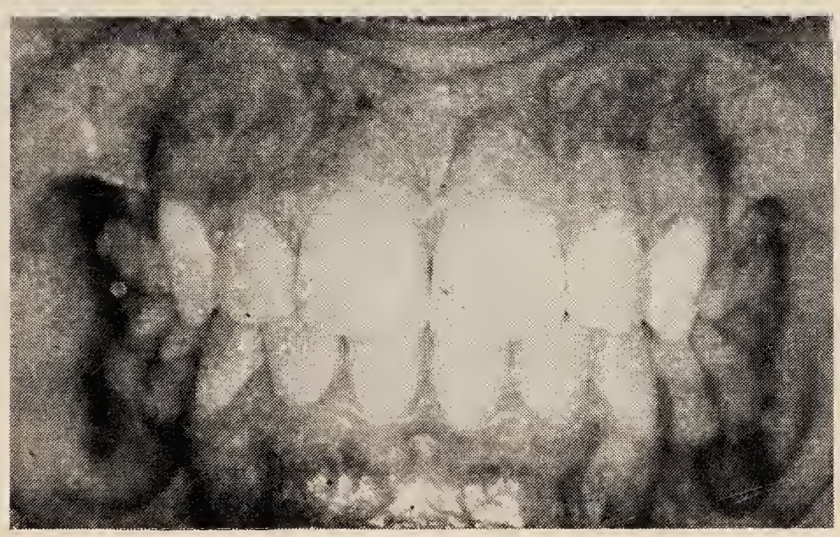
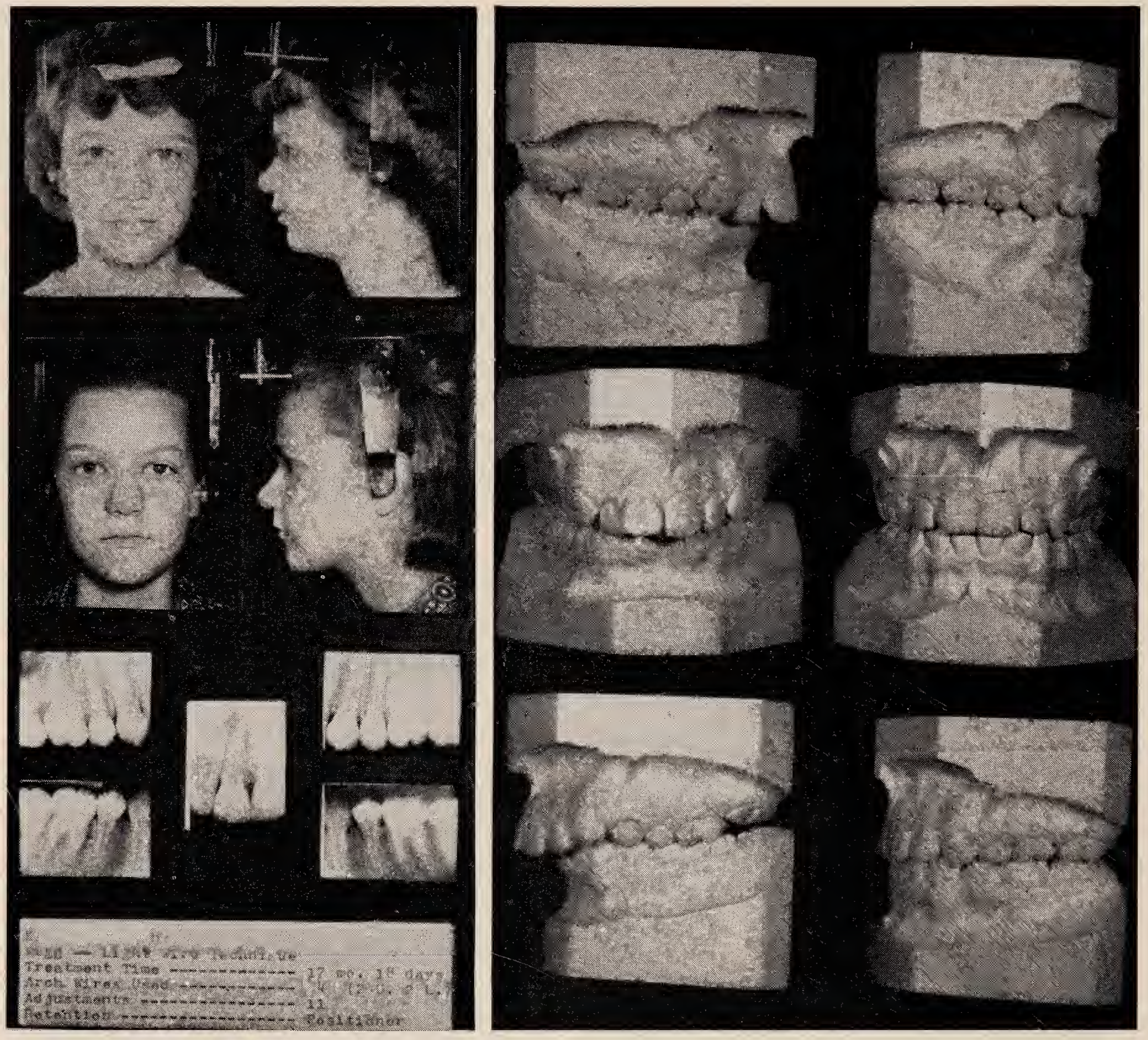


Fig. 6.—Condition at the end of treatment. Extraction spaces have been closed, crown-tipping has been corrected on all the teeth concerned. Overbite and overjet have been corrected. The case is ready for retention.

When all teeth in the canine-incisor area are in alinement (and they often assume a ‘ fanned-out ’ look at the time) (*Fig.* 2B), when incisor relationship to their antagonists is edge-to-edge and all individual malpositions are reduced this indicates the end of Stage I. Thus antero-posterior discrepancies have been corrected, maxillary and mandibular incisors are in edge-to-edge relationship, and molars are in Class I



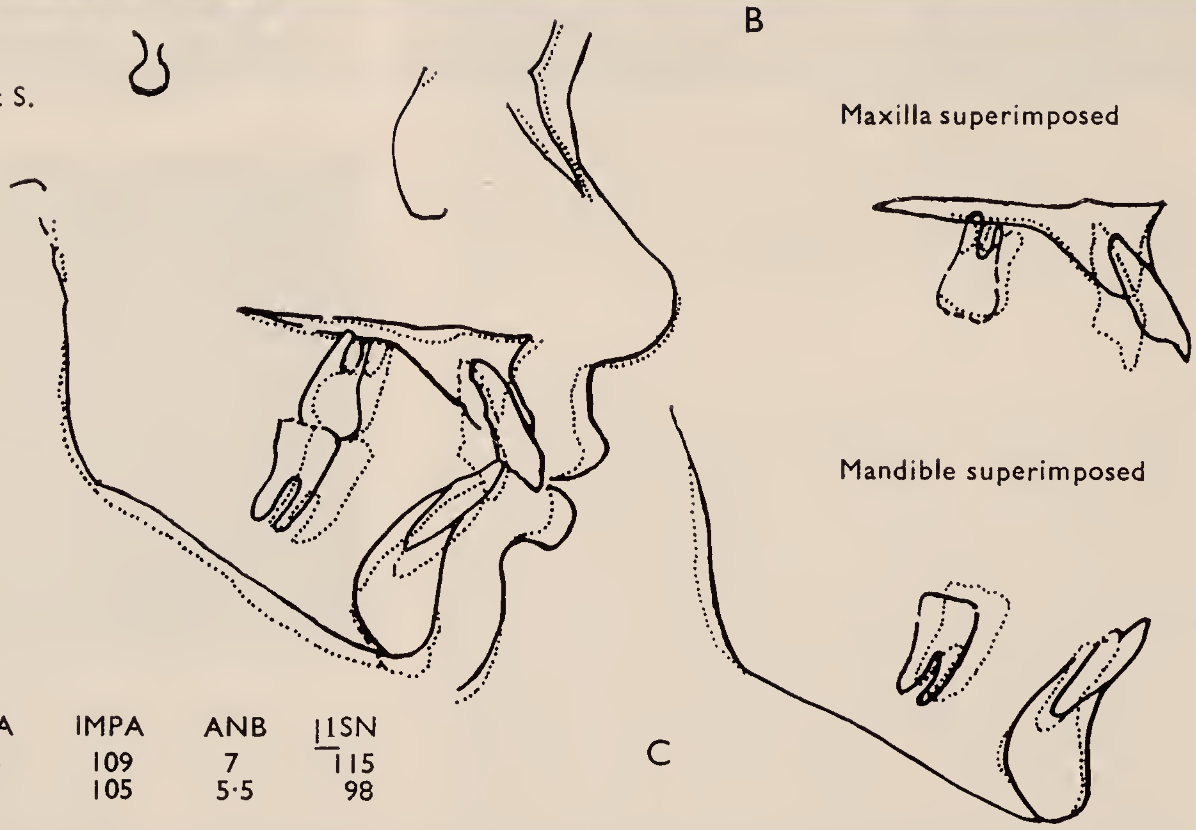


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Fig. 7.—Condition and analysis of the case illustrated before and after treatment. A, Photographs and intra-oral radiographs after treatment; B, Models; C, Superimposed lateral radiographs.

relationship even tending toward Class III (*Fig.* 2).

Stage II

At the end of Stage I extraction spaces may not have been completely used up for these improvements, and lateral spaces may still exist between the crowns of canines and second premolars (*Fig.* 3A). (In non-extraction cases, of course, Stage II is practically non-existent, since Stage I can be almost immediately followed by Stage III if torque is necessary on some of the teeth.)

During Stage II, lateral spaces between canines and second premolars are closed by using light elastic forces extending from the canine to the molar areas until tipping of the crowns is sufficient to bring them in contact (*Fig.* 3A). At the same time, incisors—particularly maxillary incisors in maxillary protrusion cases—are tipped lingually beyond the position they should assume at the end of treatment (*Fig.* 3). This is a particularly nerve-racking period in the treatment, as it illustrates precisely what we all try to avoid with other methods. Great faith in the next step of treatment is very necessary at this point!

Stage III

This is the most original part of the method. It aims at uprighting the roots under the tipped teeth in order to obtain parallelism between the axis of premolars, canines, and incisors. As may be seen on the diagram (*Fig.* 4) apices of the premolars are to be moved mesially, while apices of canines and incisors are to be moved distally or lingually according to the case. Mesial movements of the apices of the premolars and distal movement of the apices of canines are then obtained with uprighting springs.

At this point vertical slots are absolutely necessary for the use of uprighting springs. This action is surprisingly efficient and rapid. Lingual torquing of the incisors is achieved with the help of auxiliary torquing arches which have an application point near the cervical limit of the tooth (*Fig.* 5). It is important to anticipate the powerful expanding effect the torquing auxiliaries develop and to make the supporting arch much narrower in the molar area. At the same time canines, premolars, and molars are ligated together on the lingual surface by means of ligature wires which prevent separation of the crowns and apply the whole effect of the uprighting springs at the apical region of each tooth. The final condition is shown in *Fig.* 6.

Faithful wearing of rubber bands is necessary at all times, but most of all during Stage III when torquing of incisors may have very ill effects if they are not controlled by the use of rubber bands which maintain the improvements obtained during Stage I. If necessary, uprighting springs may also be used on incisors at the end of Stage III to obtain mesiodistal positioning.

Details of the treatment of the case illustrated here are shown in *Fig.* 7.

CONCLUSION

Satisfactory treatment with the technique that has been outlined requires imperatively:—

1. Good Quality Banding Material

Bands will be subjected to considerable pressure and strain in Stage III.

2. Highly Tensile and Resilient Wire

Arch wires will have to keep their shape for long periods of time.

3. Special Channel-Brackets

They should allow free sliding of the teeth along a round 0·016-in. diameter round wire.

Provide vertical channels that allow placing of lock-pins, ligature wires, and root-tipping springs.

Vertical slots to receive arch wires, with the addition of auxiliary arches to torque incisors, or to act as ' brakes '.

4. Well Calibrated Elastic Bands in Large Quantities

5. Good Patient Co-operation

Since regular wear of elastic bands is so important, lack of co-operation will tend to prolong unduly the time of treatment. If extractions have been made necessary by the type of malocclusion and co-operation fails, the orthodontist is in a very difficult position.

Treatment with the Begg light-wire technique is considerably simpler than other multiband techniques. I do not, however, think it an easy one, on the contrary, it requires much skill and thought because of the composite character of the forces used.

But, all these conditions met, this type of treatment provides the orthodontist with a method which equals the results of other multiband techniques, with much less chair time; this is where the method appears to bring something new and useful.

Acknowledgement

The illustrations presented here are those of a case treated at the Kesling-Rocke Orthodontic Group, Westville, Indiana, U.S.A. The author is greatly indebted to Drs. Kesling and Rocke for their kind permission to use this material for publication.

REFERENCES

BEGG, P. R. (1954), *Amer. J. Orthodont.*, **40**, 298, 373, 462, 517.
— — (1956), *Ibid.*, **42**, 481.
— — (1961), *Ibid.*, **47**, 38.
— — (1965), *Begg Orthodontic Theory and Technique.* Philadelphia: W. B. Saunders Co.

III. MULTIBAND APPLIANCES

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INTRODUCTION

My contribution to this Symposium is a consideration of that form of the multiband appliance where a round arch wire is used. A full range of tooth movements can be achieved using this technique; these include bodily movement, depression, and rotation of teeth. The characteristics of the appliance allow multiple tooth movements to be carried out simultaneously.

Tooth movements and anchorage are considered at two levels, first the broad view and then the detailed view. The former concerns the movement of the segments, namely labial and buccal, whereas the latter covers individual tooth movements within the segments.

I intend showing how various movements are achieved and the resultant reaction. This reaction should always be used as advantageously as possible and this, in fact, presents the challenge in the use of the multiband appliances. How circumstances modify appliance design will be illustrated with two segment movements, namely the retraction of upper incisors and the depression of lower incisors. Finally, certain individual tooth movements will be considered. However, before doing this, I would like to comment on the components of this appliance and the programme of banding and cementation.

APPLIANCE COMPONENTS

Hill (1954) described in detail the fabrication of this appliance. Since my own technique is based on this, I will only comment on certain aspects.

First, bands and their attachments. With the exception of molar bands, band blanks are used with the brackets already attached. It is only rarely the degree of displacement of a tooth makes the use of a plain band blank necessary. The band should be drawn up so that the bracket is in the middle of the crown of the tooth; exceptions are teeth requiring rotation or movement of their apices. In the former, although the band is in the middle of the crown of the tooth, the bracket is set to the side requiring labial movement. In the latter, the band and bracket are positioned near to the incisal edge of the tooth. The usual molar attachment is a tube; this may be 3 mm. or 5 mm. in length. The former is used when the molar is to be moved, the latter if the molar is to remain stationary. The 3-mm. tube is slightly off-set and angled to avoid tipping and rotation of the molar as it moves. In contrast, the 5-mm. tube is not off-set or angled. The position of the brackets and tubes should be such that, if at all possible, a level arch wire is used. This is most important as it reduces the time required to bend the arch wire.

With regard to the arch wires, simplicity is the keynote. However, elaborations from a simple level arch are quite often necessary. Stops may be required and these I consider are much better bent into the arch wire rather than soldered onto the arch wire. Stops placed in front of the molars prevent the length of the dental arch decreasing, but they do not prevent the molars moving forward if pressure is applied to these teeth, and when this occurs, there is a simultaneous movement of all the other teeth attached to the arch wire. Coupled with the problem of stops is that of whether the arch wires should be turned gingivally behind the molar tube. Just as the stop prevented the length of the dental arch decreasing, so bending the arch wire gingivally prevents length of the dental arch increasing. The ends of the arch wire are usually annealed before turning gingivally. Bent in this way the end of the arch wire makes a convenient hook for attachment of an elastic band. When traction is applied to other areas of the arch wire, I prefer to bend loops into the arch wire rather than to solder on hooks.

To turn to the subject of auxiliaries, which are used to accomplish individual tooth movements, I have a preference for push coils on the arch wire. These are usually made from 0·15-mm. hard stainless-steel wire wound on a 0·7-mm. core and are wound closed. An appropriate length is selected; this is placed on a piece of arch wire and opened with the exception of the few end turns of the coil. The coil is then compressed a few times to give its true length. Frequently, an auxiliary wire is used to achieve rotation of a tooth; this is made from a thin gauge of arch wire of the order of 0·014 in. or 0·016 in. The auxiliary is used in combination with an off-set bracket and very often a spur. The spur is formed from 2·5-mm. × 0·25-mm. tape, and is soldered to the band on the opposite side to the off-set bracket. The end of this spur is slightly grooved in order to accommodate the arch wire. This spur over-rotates the tooth, which is most important if alinement of the tooth is to be maintained when appliances are discarded.

Various dimensions of high-tensile wire are used to form the arch wire and these are now listed with an indication of their use:—

0·014 in.—Auxiliary arch.
0·016 in.—Levelling or auxiliary arch.
0·018 in.—General working or levelling arch.
0·020 in.—Occasional working or stabilizing arch.
0·022 in.—Stabilizing or retaining arch.

Three gauges of soft stainless-steel wire are used to form ligatures. If the tooth is to be moved along the arch wire, 0·25-mm. soft wire is used and the ligature tied by hand. Tied in this way, the ligature is sufficiently loose to allow the tooth to move. In all other situations, Howe pliers are used to tighten the ligatures. The push coil used to achieve movement of the tooth along the arch wire is compressed with ligature formed from 0·007-in. soft wire. This wire is also used to tie teeth together and thus form them into a block.

Fig. 1.—' Bull ' loop arch to retract the upper incisors with attachments for various forms of traction.

0·3-mm. wire is used if the tooth is to be drawn progressively nearer the arch wire or fully tied in initially.

PROGRAMME OF BANDING AND CEMENTATION

The construction of a multiband appliance is fairly time consuming. This fact must be faced and it is best resolved by allocating the patient a block of appointments. While the appliance is being constructed, the average period between appointments is a week, but in cases where the contact points between the teeth are very tight, ideally separators should be inserted a few days before the first visit to make bands. An alternative in extraction cases is to have the teeth extracted approximately 10 days before bands are to be made; in most cases, sufficient drifting of the teeth will have occurred to loosen the contact points. When separators are used these are normally made from 0·5-mm. soft brass wire for the posterior teeth, but occasionally 0·7-mm. soft brass wire is desirable. 0·3-mm. soft stainless-steel wire is used to separate anterior teeth. Adequate separation of teeth considerably simplifies band construction and cementation. In many cases, only a few bands require to be made to start treatment. Later, more teeth are banded as treatment progresses and these are made when the patient attends for adjustment to the appliances. For example, following extraction of the lower first premolars initially bands are placed on the lower canines, second premolars, and first molars. If bands are required for the lower incisors, in most cases these are better made later.

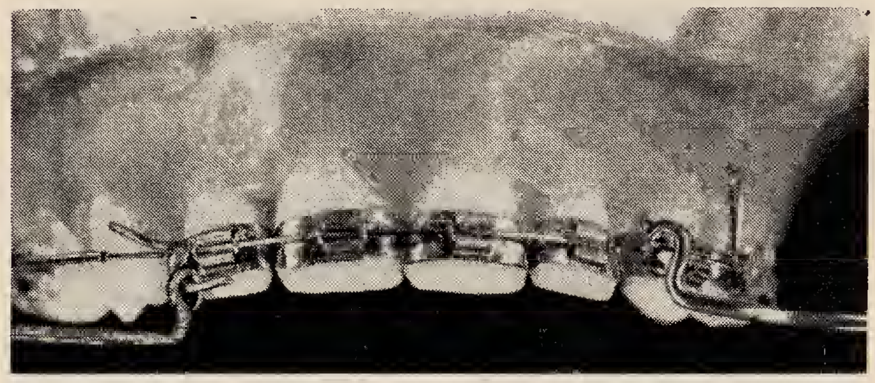


Fig. 2.—Two types of extra-oral attachment:—The right side shows the extra-oral arm formed into a hook to engage the traction loop; The left side shows the extra-oral arm formed into a loop to thread onto the soldered hook.

APPLIANCE DESIGN

How circumstances determine appliance design is best shown by means of a series of illustrations. First, cases where palatal tilting of the upper incisors is the appropriate method of retraction.

Assuming that only part of the space between the upper incisors and canines is required for the upper incisors, an appliance of the type shown in *Fig.* 1 would be appropriate. Here all the teeth forward and including the first molars have been banded. The teeth are in two blocks, the buccal consisting of the canines, second premolars, and first molars; and the labial block consisting of the central and lateral incisors with a space between the two blocks. Retraction of the upper incisors and space closure is achieved by a ' Bull ' loop arch made from 0·018-in. high-tensile wire. The Bull loop is sufficiently far in front of the second premolar bracket that the arch can be pulled through the molar tube to activate it. The arch is turned towards the gingival margin behind the molar tube in order to create a continuous pressure to reduce the length of the maxillary arch. It is important to have the Bull loop closed in its inactive state in order to judge the amount of activation. To facilitate the retraction of the upper incisors, the arch wire is not tied into the upper canine bracket, instead the canine is tied to the first molar so that there is no tendency for the three buccal teeth to separate.

There are occasions where, although retraction of upper incisors and some forward movement of the upper buccal teeth is required, if the mechanism described above was used the correct amount of retraction of the upper incisors would not

coincide with space closure. In certain cases, providing the correct amount of upper incisor retraction has been achieved, a slight space distal to the incisors would close spontaneously when appliances are discarded, by forward drifting of the upper buccal teeth. However, this is not always so and, therefore, consideration has to be given to ways of increasing and decreasing the movement of the two segments. This is done by using anchorage outside the maxillary arch. It can be seen in *Fig.* 1 that a traction loop has been bent into the arch distal to the upper lateral

could be applied to the labial segment to assist its retraction while extra-oral traction is applied to the buccal segment to resist its forward movement.

The foregoing examples show how precisely tooth movements can be controlled with the multiband appliance.

In cases where the upper incisors require retraction without any forward movement of the upper

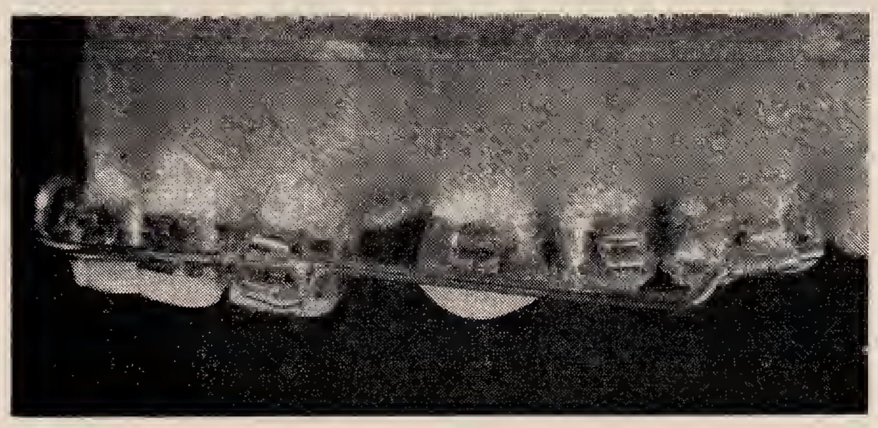


Fig. 3.—Stopped buccal arch with soldered hook for attachment of extra-oral or Class II intermaxillary traction.

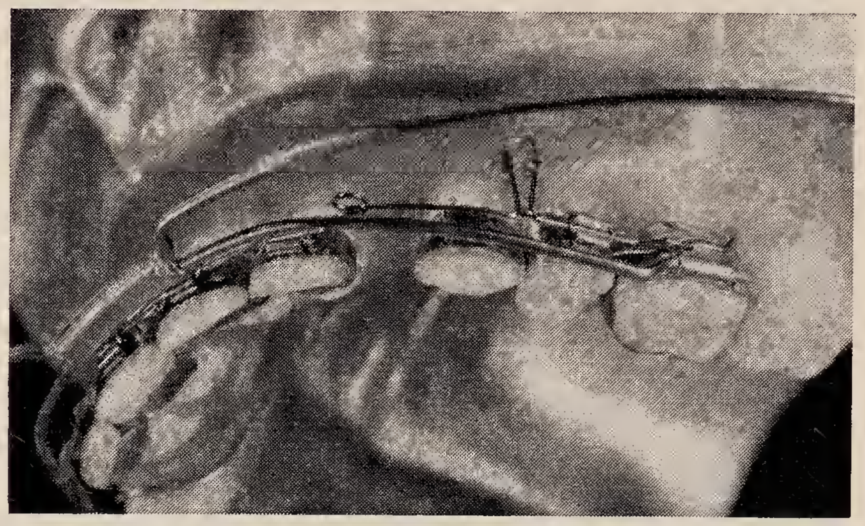


Fig. 4.—'Kloehn' type of extra-oral bow to supplement the buccal anchorage.

Fig. 5.—Free sliding sheathed arch to retract the upper incisors.

Fig. 6.—'Bull' loop arch to depress the lower incisors.

incisors. This loop is a convenient point of attachment for either Class II intermaxillary traction or extra-oral traction (*Fig.* 2) or both. These forms of traction increase upper incisor palatal movement. On other occasions forward movement of the upper buccal teeth has to be retarded or prevented. This can be achieved by exerting either Class II intermaxillary traction or extra-oral traction to the upper first molars. If both extra-oral and Class II intermaxillary traction are to be applied to the buccal teeth, I would recommend a buccal arch of the type shown in *Fig.* 3. It is a matter of individual preference whether a 0·7-mm. soft stainless-steel hook is soldered to the buccal arch or a traction loop bent into the arch. My own preference is to bend a loop into the arch wire. Of necessity, the extra-oral attachment is slightly different in the two cases, these can be seen in *Fig.* 2. In those cases where it is decided to use only extra-oral traction to the buccal teeth, a ' Kloehn ' type of bow is recommended (*Fig.* 4). In *Fig.* 4 it can also be seen that Class II intermaxillary traction

buccal segments a simple appliance is shown in *Fig.* 5. In this case the upper first molars were banded and a palatal arch constructed which crosses the palate in the canine region; 0·7-mm. soft stainless-steel wire stops were soldered to the palatal arch to hold the canines in their retracted position and thus form the buccal teeth into a block. Bands were placed on the incisor teeth and an 0·018-in. arch wire constructed with most of the buccal part of the wire sheathed in 0·5-mm. stainless-steel tubing. Either a hook is soldered to the arch wire or a traction loop bent into the wire. The arch slides freely through the 1·0-mm. tube soldered to the buccal of the molar band. Class II intermaxillary traction or extra-oral traction is applied to the arch wire thus activating the appliance. The second 1·0-mm. molar tube makes it possible to apply Class II intermaxillary or extra-oral traction to the buccal segments or even to the whole of the upper arch if the arch is turned gingivally behind the molar tubes. There is, however, a point of danger in attempting to move the whole of the maxillary

dentition distally with this appliance, namely imbrication of the upper second premolars and canines. The solution is to band these teeth.

Only rarely do the upper incisors require bodily retraction. The use of a multiband appliance to do this has been previously described (Parker, 1963). Each tooth requiring bodily movement is subject to two forces, one directed through the band bracket channel, the other through a vertical spur. These forces produce problems of anchorage which are much greater than those encountered in the palatal tilting of the incisor teeth.

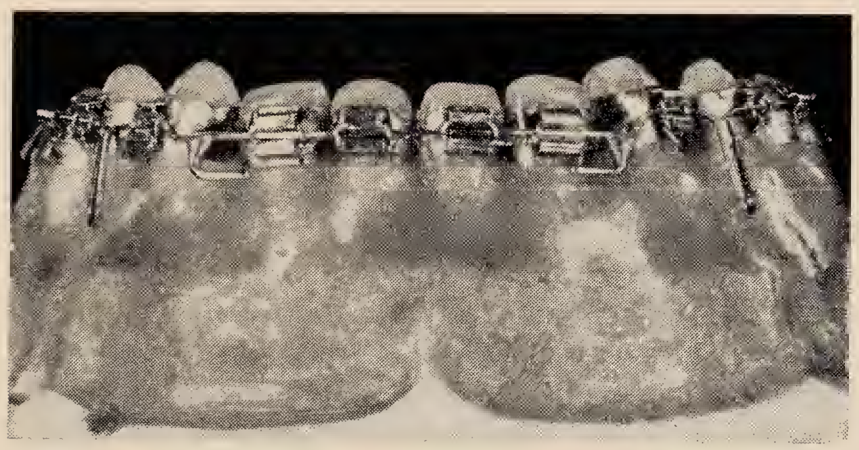


Fig. 7.—'Bull' loop arch with hooks for the attachment of Class III intermaxillary or extra-oral traction.

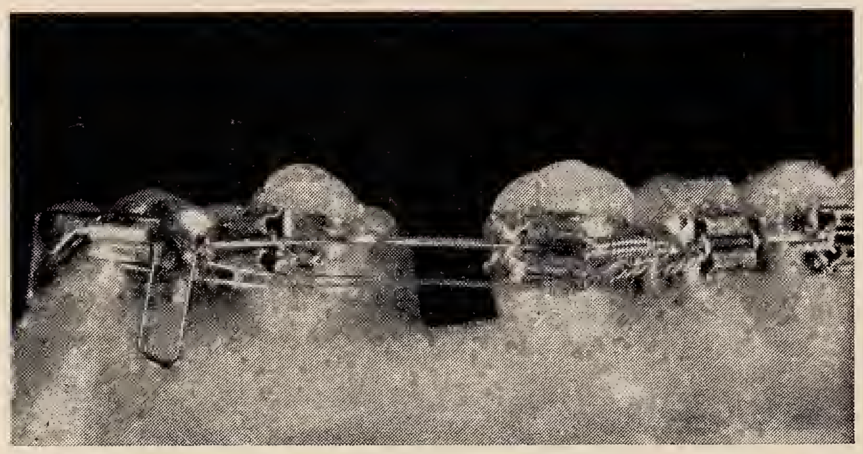


Fig. 8.—Lower arch with push coil to move the canine distally and a third power bend to rotate the second premolar buccally.

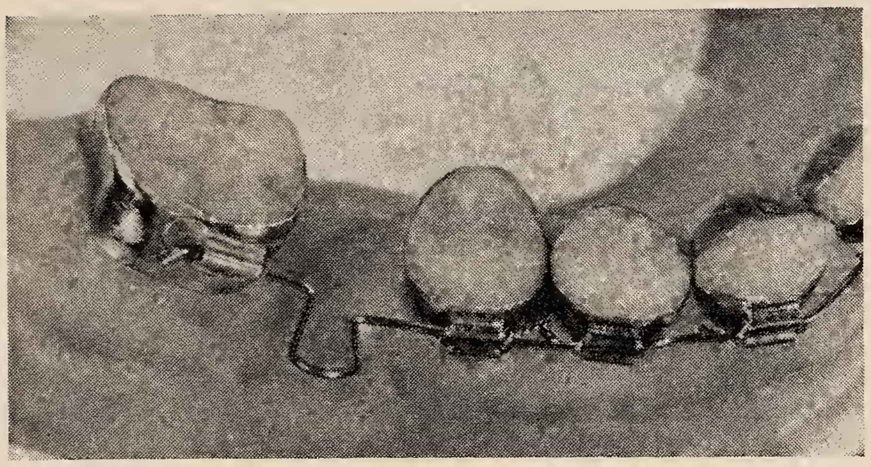


Fig. 9.—'U' loop arch to close residual first molar space.

Fig. 10.—Lower arch to increase second premolar space by means of a push coil and an auxiliary arch.

A problem often associated with retraction of the upper incisors is the need for ' depression ' of the lower incisors (Parker, 1964). After extraction of the lower first premolars a series of arch wires is used with the object of levelling the lower occlusal plane. Since any force to depress the lower incisors would also procline these teeth, lingual pressure has also to be applied to the lower incisors. To start the levelling of the lower occlusal plane either a 0·016-in. or even a 0·014-in. level arch wire is used with the arch turned gingivally behind the molars. As soon as practical a 0·018-in. arch wire is inserted with a Bull loop in the first premolar region; the loop is positioned near to the canine to allow the arch wire to be drawn through the molar tube to produce some lingual pressure on the lower incisors. The illustration (*Fig.* 6) shows a step down bend mesial to the lower canines; this is desirable only in certain cases. As previously stated for the upper arch, not only should the incisor position be corrected, but, in general, spaces should also be closed. Forward movement of the lower buccal teeth shown in *Fig.* 6 could be promoted by the use of these teeth as a source of Class II intermaxillary anchorage. Conversely, where space is critical, lingual pressure can be brought to bear on the lower incisors by use of either Class III intermaxillary or extra-oral traction. To achieve this, loops can be bent into the arch wire or hooks soldered to the arch in the positions shown in *Fig.* 7.

After considering the broader problems of segment movements, I propose considering a few individual tooth movements.

Prior to repositioning the incisors in the majority of cases movement of the canines has first to be carried out. This is usually a matter of moving the canines distally following extraction of the first premolars. A convenient way of achieving this is by means of an open push coil which is slipped onto the arch wire and activated by compressing it with a 0·007-in. ligature which is passed behind the molar tube (*Fig.* 8). The wire of the push coil is 0·15-mm. hard stainless-steel wire wound on a 0·7-mm. diameter core. This illustration is atypical because in most cases the lower incisors are not banded and there is no stop placed in front of the molar tube. It does,

however, show that several individual tooth movements can be carried out simultaneously, for example, rotation of the second premolar buccally as the canines are moved distally. It is important to realize that the third power bend to rotate the premolar is also acting as a stop mesial to the molar and that, since the lower incisors are banded, any forward movement of the molar will result in labial movement of the lower incisors.

On occasions, the quality of the lower first molars is so poor that these teeth have to be selected for extraction in a case where orthodontic treatment is to be carried out. On other occasions, the lower first molars have already been removed. The problem here is to counter the tendency of the lower second molar to tilt forward and rotate mesiolingually. Much can be done by placing the molar tube in the correct position (*Fig.* 9). Since the molar has to be moved, a 3-mm. tube should be used; this should be placed on the buccal aspect of the tooth towards the mesial, and with a slight downward inclination. A 0·018-in. arch wire is used with a Bull or ' U ' loop opposite the residual first molar space, but sufficiently in front of the second molar to allow activation of the loop by pulling the arch wire through the molar tube prior to turning it gingivally. The arch wire is turned gingivally to encourage forward movement of the apex of the second molar and resist distal movement of the crown. The wire distal to the loop should have an approximate 30° downward and lingual inclination; this is particularly important in those cases where Class II intermaxillary elastic will be hooked over the arch wire behind the molar tube to assist the forward movement of the second molar.

Finally, I would like to consider a case with inadequate space in the lower premolar region and lingual displacement of the second premolar. On its own, this condition would not require a multiband appliance for its correction, but in cases where a multiband appliance is required for other reasons, the appliance lends itself to easy correction of the abnormality. The appliance is shown in *Fig.* 10. The main arch wire is 0·020 in. in diameter with a 0·5-mm. brass stop soldered to the arch just distal to the first premolar. An open push coil of 0·15-mm. hard wire wound on a 0·9-mm. core is placed on the arch wire and compressed between the stop and the 1·0-mm. tube on the first molar band. The wide tube was used to allow distal tipping of the first molar. To promote the buccal movement of the second premolar a 0·3-mm. or 0·35-mm. auxiliary arch is threaded through the incisal tie channels of the first and second premolars and the small diameter tube on the first molar. If necessary, the tendency for the anterior block of teeth to move labially can be resisted by the use of either extra-oral or Class III intermaxillary anchorage, which is the reason for incorporating the traction loop into the arch wire mesial to the canine. Supplementation of the anterior anchorage is particularly important in those cases where the apex of the molar is moved distally following distal movement of the crown. To achieve this, a 0·018-in. arch wire is passed through the smaller diameter molar tube, the arch wire in its passive position should lie above the occlusal plane of the lower incisors and should have a stop immediately in front of the molar.

In conclusion, I would like to state my anticipation of criticism of the multiband form of therapy. However, I will state my conviction that the recent improvements in our knowledge of the factors determining occlusion and, in turn, our prognostic skills have done much to justify this high degree of precision in tooth movements.

Acknowledgements

I would like to thank Professor C. F. Ballard for permission to use the illustrations, which I prepared whilst I was on the staff of the Eastman Dental Hospital, London. I am also grateful to my secretary, Miss S. J. Peel, for typing the script.

REFERENCES

Hill, C. V. (1954), *Dent. Practit.*, **5**, 2.
Parker, C. D. (1963), *Ibid.*, **14**, 215.
— — (1964), *Ibid.*, **15**, 66.

IV. PANEL DISCUSSION

Mr. C. D. PARKER, Dr. P. H. DÉMOGÉ, and Mr. J. S. BERESFORD

Dr. J. R. E. Mills: **Do the members of the panel ever use removable appliances in conjunction with fixed appliances, that is using removable for one part of the treatment and fixed for another? Secondly, would Dr. Démogé and Mr. Parker discuss their respective uses of different types of brackets?**

Mr. C. D. Parker: Yes, I do use both appliances, but use the multiband more in the lower than in the upper arch. I use it where bodily movement of teeth or rotations is required. I prefer the conventional type of bracket because this limits the amount of tilting which is possible in the tooth. The type of bracket which Dr. Begg

uses throws the arches into such confusion that I do not know where the teeth are and I prefer to keep them under more rigid control.

Dr. P. H. Démogé: In many cases, removable appliances are wonderful. I very firmly believe in doing things easily. I use them particularly in two cases—first, in cases of crowding where premolars have to be extracted and the canines retracted, I like to carry out this movement in both arches with removable appliances. Secondly in what I call active retention, I like to use an activator at the end of treatment and I think this allows earlier removal of the bands. The activator also helps to check the growth pattern if it exists towards a Class II condition. With regard to the second question, I think the vertical slot is preferable, particularly where mesiodistal apical movement is required and an auxiliary wire can then be inserted into the slot to bring about this movement.

Mr. J. S. Beresford: I think that if removable and fixed appliances are going to be mixed, there should be very good reasons for doing so. I am obsessed with the necessity of not wasting my own time or that of the patient. Almost everything can be done with fixed appliances and, having decided that a fixed appliance can be used, then I think the orthodontist should get on with it. Clearly, there are exceptions to this rule and some have been shown in my paper. With regard to the monobloc, some patients like them and others do not. There are two kinds of patients to whom I do not like giving them. First, the child who has had one before unsuccessfully and, secondly, the child who has previously worn fixed apparatus free from responsibility who does not face up readily to the responsibility of a monobloc.

Mr. G. H. Steel: Judging from the illustrations, there appears to be a great variation in the bracket height. Mr. Beresford sets his bands high while the other speakers set theirs quite low.

Beresford: I put my bands high partly for aesthetic reasons to keep them out of sight as much as possible and partly because it minimizes tilting of the teeth labiolingually.

Démogé: I think that people who band all the teeth tend to put their brackets closer to the incisal edge, since it is important that the brackets on all the teeth are at the same distance from the incisal edge or tip of the cusp. This makes it easier to get the brackets into line with the premolar brackets.

Parker: I think the question has been covered by the other two speakers. One point is the shape of the crown of the tooth. If the band is too high, it tends to work its way up and into the gum where it becomes loose, whereas if it is nearer to the incisal edge, it comes free into the mouth and the patient knows that attention is needed.

Mr. B. B. J. Lovius: **Does Dr. Démogé use an active or a passive monobloc? Also, did Dr. Démogé speak of changing the apical base during treatment?**

Parker: The type of retention appliance I use is one with clasps on the first molars and a labial bow fitting round the incisors. I do not use the monobloc very much. When I do, I use it as an active appliance, not a retainer. I believe that retention is retention and not tooth movement and is, in many cases, not required.

Beresford: I think that a retention appliance is necessary when the fixed appliance is removed for two reasons. First, there is the obvious reason to support the tooth at night while the parodontal tissues adapt themselves to support the tooth in the day-time. Secondly, because the Americans, who are no fools in this, retain their cases for a long time.

Démogé: On the whole, I go along with Begg, but I would add this point. In some cases we deal only with the movement of teeth, but, in others, it seems that something has occurred to interfere with the genetic 'blueprint ' of the growth potential. This seems to be the case in protrusion where orthodontic treatment may change the effect of this growth pattern which is unacceptable. I cannot think we change the growth pattern itself, but only enable the patient to achieve his inherent growth pattern.

Very often, in using multiband appliances, treatment is pretty fast—eighteen months to two years. Very often the patient has not then finished growing. The activator is easy to wear and most patients accept them very readily. It acts as a check on the growth until growth is finished when it can be discarded. I think retention is a good thing and that it should be kept up for a long time because we do not know what is going to happen, particularly in a patient who has been treated quickly and where a lot of growth is still to come.

The President: **There are many different kind of activators that can be made with a protrusive bite or with a normal bite. Would Dr. Démogé indicate how he uses them?**

Démogé: Yes. I usually put them in a slightly protruded position in relation to the original situation and see the patient every three months and I just trim where I think it is necessary. Mr. Lovius asked me a question about changing the dental base relationship. What I meant was that the relationship between A and B point seemed to change after treatment as measured by the X-rays. Whether this is a continuing change in the relationship of the mandible and maxilla I do not know.

Parker: I find a most useful instrument is a diamond wheel. I often use this towards the end of treatment to adjust the occlusion and make it more stable.

Mr. R. Stewart Bell: **In relation to lower arch treatment, where two premolars are extracted, how does the panel determine the final position**

of the labial segment. In Class II cases, do they advise the use of permanent retainers and, if so, what design do they take?

Beresford: I imagine there is a neutral line in balance of soft tissues which the incisors will always take. I therefore move them round the arch trying to keep in this line and carrying out any rotations. When they are alined, I let them go.

Regarding the use of permanent retention in Class II, division 1, I would only use this if there were a very good reason for doing so and I was quite satisfied that the patient was suitable for the use of a permanent retainer. I think it would involve a fairly precision type of appliance.

Parker: I think that in a Class I case, the position of the lower labial segment which one would hope to achieve would be a mean one. No doubt there will be some variations in different types of malocclusion and I do not think it is possible to generalize. A lot depends on the soft tissues.

With regard to permanent retention, every patient has a right to change his appearance and, if a permanent retainer is the only way of giving an acceptable cosmetic appearance, and the patient understands that this may be damaging their teeth, then I think it is advisable. I would emphasize, however, that I would regard this as quite exceptional and that most cases do not require retention—they are self-retaining. I prefer a permanent retainer to be made from a material such as chrome cobalt.

Démogé: It is important to decide beforehand where the lower incisors belong. Standards have been suggested by various authorities, but really the teeth will tell you where they are happy.

Earlier I mentioned the use of removable appliances in retracting canines and one advantage of this is that the incisors first tip into the position in which they are in balance and then they start to separate. This seems to give the position one should try to achieve.

Using Class II traction, the forces will tend to tip the lower incisors labially and this has to be taken into account so that if you are going to use Class II traction, the lower incisors should first be tipped lingually a little. Regarding permanent retention, Mr. Beresford and Mr. Parker have dealt with the matter very clearly, but I would like to add one thing. If you use a permanent retainer, you will find that the patient goes away for a period of weeks, comes back having left it out, and you will be right back where you started!

Parker: I would like to clarify my remarks about permanent retention. I would certainly explore the possibility of a radical repositioning of the teeth, perhaps in consultation with the oral surgeon or plastic surgeon, before I was at all enthusiastic about a permanent retainer.

The President: We have had a very interesting discussion but unfortunately time does not allow us to continue, but I am sure you would all wish me to thank the contributors to the discussion.

BORDERLINE CLASS III CASES

M. L. BRENCHLEY, B.D.S., F.D.S., D.Orth. R.C.S

Senior Registrar, Eastman Dental Hospital

THE commencement of orthodontic treatment for the majority of children requiring it should be delayed until the premolars, and/or canines, are erupting, in an attempt to reduce the overall treatment time (Fletcher, 1958).

A common exception to this is where there is an occlusal relationship in the mixed dentition producing a displacement of the mandible on closing. In these cases early treatment to eliminate the displacing activity is probably indicated. Thereby the remaining permanent teeth on eruption can occlude in a centric jaw relationship with as good an interdigitation as the skeletal, soft tissue and dental factors permit. We have all experienced the difficulties in treating this type of case when the permanent dentition is fully established and the occlusal relationship of maximum cuspal interdigitation is not a centric jaw relationship. No sooner is the tooth moved which is apparently causing the displacement, than it would appear that another tooth is acting as an initial contact and perpetuating the displacing activity.

Many malocclusions in which upper incisors are in lingual occlusion demonstrate such a mandibular displacing activity. This group, having in common lingually occluding upper incisors, includes a wide range of malocclusions from the mildest, which are simple to treat, to the most complicated, which have a poor prognosis. In its least complicated form, one upper incisor, usually a palatally tilted lateral incisor, occludes lingually to a lower incisor which may be labially tilted. On a relaxed, retruded path of closure, the incisor inside the bite can meet the opposing lower incisor edge to edge, from which the mandible displaces forwards and possibly laterally into an occlusion of maximum cuspal interdigitation. The dental base relationship is Class I and the degree of incisor overbite is normal or increased. Malocclusions with similar features in which all four upper incisors are in lingual occlusion are often described as postural Class III cases.

The more severe malocclusions which are in this same group, and which show a displacing activity, may have a dental base relationship varying from mild to moderate Class III with incisor inclinations and degree of overbite such that the simple treatment of moving the upper incisors labially over the bite is not possible. Consequently, many of these can be seen at diagnosis to require the extraction of mandibular teeth to enable anteroposterior contraction of the lower arch to be achieved as well as relieve any crowding that may be present. The lingual movement of the lower incisors can be carried out simultaneously with labial movement of the upper incisors, and is essential in many cases to produce a stable correction of the incisor crossbite that is not traumatic. A traumatic incisor relationship may be present if the lower incisors support the upper incisors labially to their position of soft-tissue balance. The upper incisors are then being 'jiggled' as a result of a labial force in occlusion and a palatal force at rest.

Therefore, a 'borderline' case may present a problem that can only be solved by attempting to move the upper incisors labially to correct the incisor relationship and then, if necessary, modifying the treatment plan accordingly.

The following two case reports illustrate this uncommon problem:—

CASE REPORTS

Case R.L. Born 9 March, 1950 (*Figs.* 1A, B, 2, 4A).

8 *September*, 1959: He presented to the orthodontic department when the following notes were made:—

'He has a Class III malocclusion and a Class III dental base relationship. He can just make his upper and lower incisors meet edge to edge when he displaces his mandible forward and overcloses to achieve occlusion of his posterior teeth. In the upper arch, early loss of $\underline{E|E}$ has allowed $\underline{6|6}$ to rotate forward, and there is insufficient space for the upper premolars and canines. Radiographs confirm the presence of a full complement of developing teeth.

TREATMENT: Move $\underline{1|1}$ labially over the bite to eliminate the displacing activity. Later the extraction of $\frac{4|4}{4|4}$ will be necessary.'

15 *January*, 1960: An upper removable appliance was fitted to move $\underline{1|1}$ labially.

23 *March*: It was noted that $\underline{1|1}$ were over the bite and the finger spring was made passive.

12 *August*: In view of the obvious instability of $\underline{1|1}$, shown by their continued mobility and tendency to relapse palatally whenever the appliance was left out, it was decided to delay further treatment until the premolars erupted.

6 *October*, 1961: The decision was made to extract $\frac{4|4}{E4|4E}$ ($\overline{E|E}$ were submerging).

Presented at the Country Meeting held in Birmingham on 30 April, 1965.

Fig. 1.—Photographs. A, *Case* R.L., 15 Jan., 1960. B, *Case* R.L., 23 April, 1963. *Left side*—at rest; *right side*—in occlusion. C, *Case* L.B., 30 March, 1965. At rest.

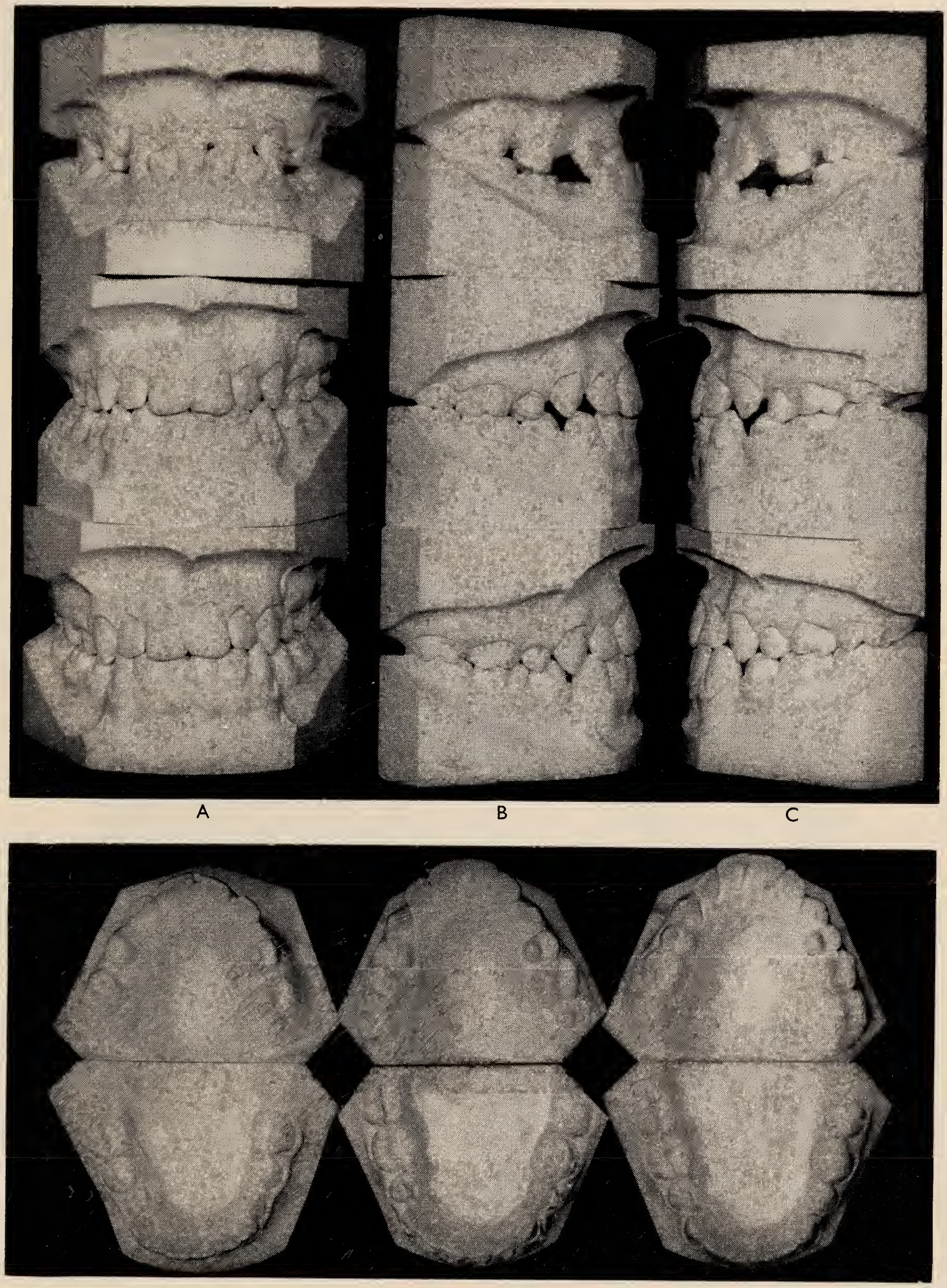


Fig. 2.—Study models. *Case* R.L. A, Front view. B, Right lateral view. C, Left lateral view.—Top, 17 Dec., 1959; Middle, 14 Feb., 1963; Bottom, 5 Aug., 1964. D, Occlusal view—Left, 17 Dec., 1959; Centre, 14 Feb., 1963; Right, 5 Aug., 1964.

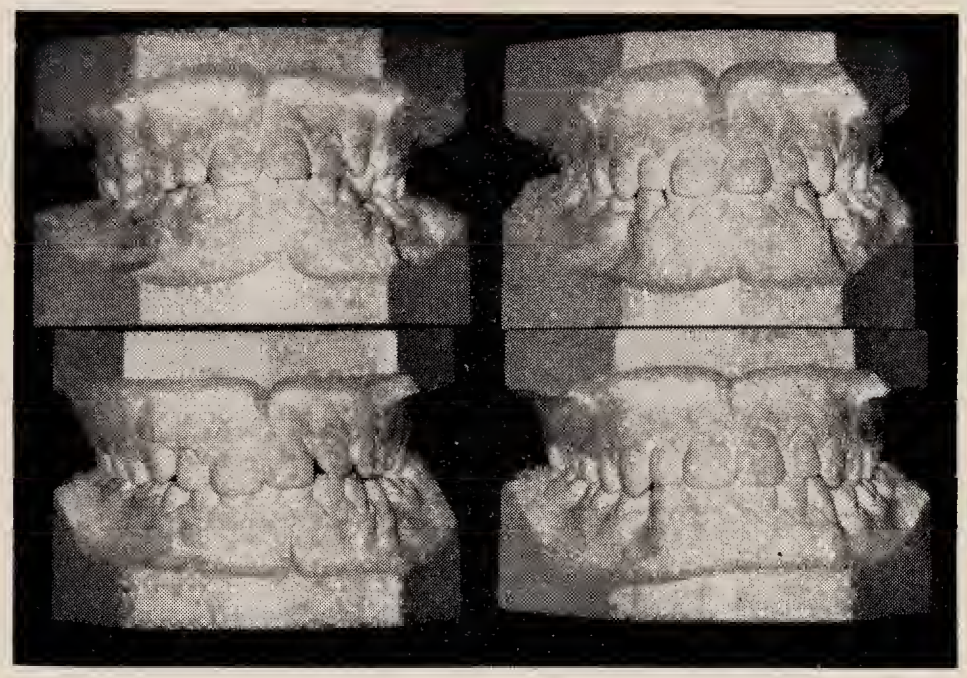
16 *April*, 1962: $\overline{653|356}$ bands were cemented, a 1·0-mm. lower lingual arch fitted, and elastic ligature tied in to move $\overline{3|3}$ distally.

18 *May*: The lower lingual arch was removed. $\overline{21|12}$ were banded and a free-sliding 0·020-in. arch with hooks for extra-oral traction from a headcap was fitted. $\overline{3|3}$ were tied back to $\overline{65|56}$.

28 *April*: A lower removable retainer was fitted incorporating buccal springs to move $\overline{3|3}$ lingually.

20 *September*: The lower removable retainer was discarded.

4 *January*, 1965: It was noted that $\underline{21|12}$ were firm, but as the overbite was minimal, it was decided that the occlusion should be kept under observation.



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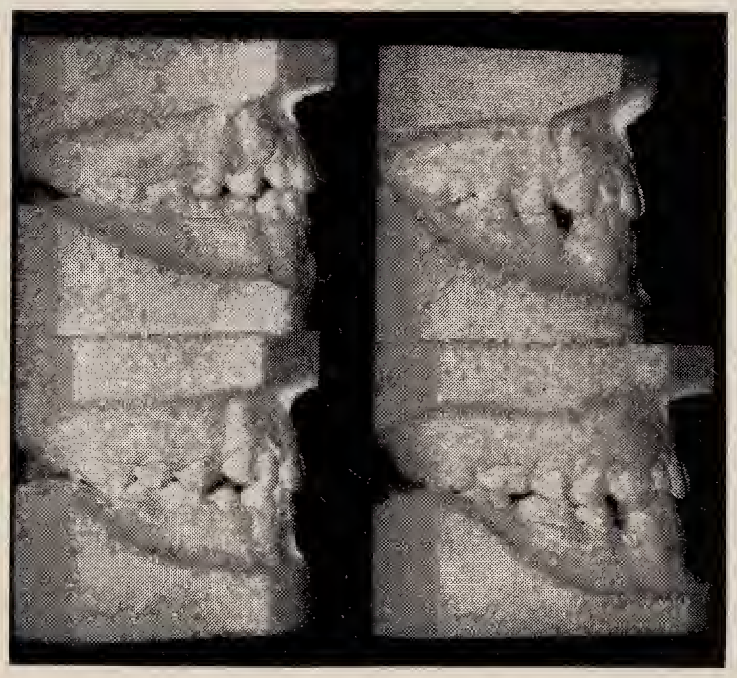

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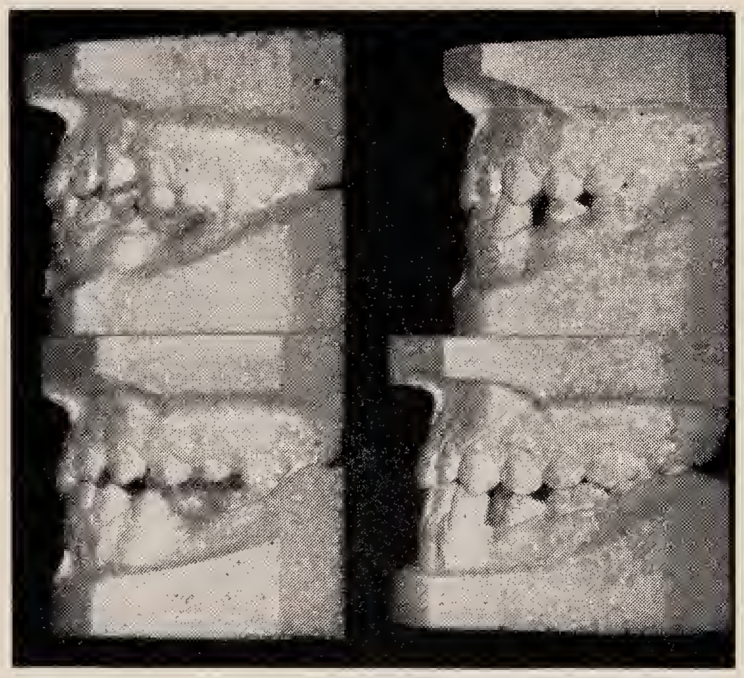

C

D

Fig. 3.—Study models. *Case* L.B. A, Front view. B, Right lateral view. C, Left lateral view —*Top left*, 8 Jan., 1960; *Bottom left*, 20 June, 1960; *Top right*, 25 Sept., 1961; *Bottom right*, 30 March, 1965. D, Occlusal view—*Top left*, 8 Jan., 1960; *Top right*, 20 June, 1960; *Bottom left*, 25 Sept., 1961; *Bottom right*, 30 March, 1965.

17 *August*: $\underline{3|3}$ had now erupted. $\underline{6|6}$ were banded and a palatal arch fitted for use with Class III elastics full time. The headgear was discarded.

10 *September*: A note was made that $\underline{21|12}$ were now over the bite with a minimal overbite.

29 *February*, 1963: An upper removable traction plate was fitted to use with Class III elastics in an attempt to bring forward the upper buccal segments to support the upper labial segment.

23 *April*: The upper removable traction plate was discarded and the lower bands removed.

Summary

The first attempt at treatment took eight months and consisted of:—

1. Two months' active treatment.
2. Six months' combined active treatment and retention.

The second attempt at treatment took seventeen months and consisted of:—

1. Twelve months' active treatment.
2. Five months' retention.

Case L.B. Born 15 July, 1950 (*Figs.* 1C, 3, 4B).

8 *January*, 1960: She presented to the orthodontic department when the following notes were made:—

'Slight Class III dental base relationship. Minimal crowding. $\lfloor 2$ is in lingual occlusion, with a very slight forward and left lateral displacement of the mandible on closing. History of 'painful jaw' six months before which subsided spontaneously. Mother noticed recently that 'her jaw was to one side'.

TREATMENT: Move $\lfloor 2$ labially with a removable appliance and then keep occlusion under observation.'

28 *January*: An upper appliance was fitted to move $\lfloor 2$ labially across the bite.

25 *February*: It was noted that $\lfloor 2$ was over the bite but showed no overbite.

4 *July*: As $\lfloor 2$ was now proclined sufficiently, but showed no overbite, an upper removable retention plate was fitted with the acrylic contacting the lingual surface of $\lfloor 2$ in a 'knife-edge' to hold it forward, but not prevent its further eruption if this were to occur.

5 *August*: It was noted that a very slight overbite of $\lfloor 2$ was now present.

30 *November*: As it was obvious that $\lfloor 2$ would not remain stable occluding labially to $\lceil 2$, but tended to relapse palatally whenever the retainer was not worn, the decision to collapse the lower arch antero-posteriorly was made, and the extraction of $\overline{4|4}$ arranged.

8 *February*, 1961: $\overline{653|36}$ were banded ($\lceil 5$ was still unerupted) and an 0·018-in. arch fitted with push coils to move $\overline{3|3}$ distally. By this time, $\lfloor 2$ was occluding lingually again.

26 *April*: As $\overline{3|3}$ were moved distally, $\overline{21|12}$ had spaced and $\lceil 2$ had dropped in to occlude lingually to $\lfloor 2$, but only the minimal overbite was present. A Bull loop arch was fitted to retrocline $\overline{21|12}$.

19 *May*: The lower labial segment was now alined and $\lfloor 2$ overbite had increased.

28 *July*: $\lceil 5$ had now erupted sufficiently and was banded.

11 *September*: The alinement of $\lceil 5$ was completed.

25 *September*: The lower bands were removed.

3 *March*, 1964: It was noted that the incisor relationship was not traumatic and the incisor overbite had reduced a little.

30 *March*, 1965: No change was noted from above.

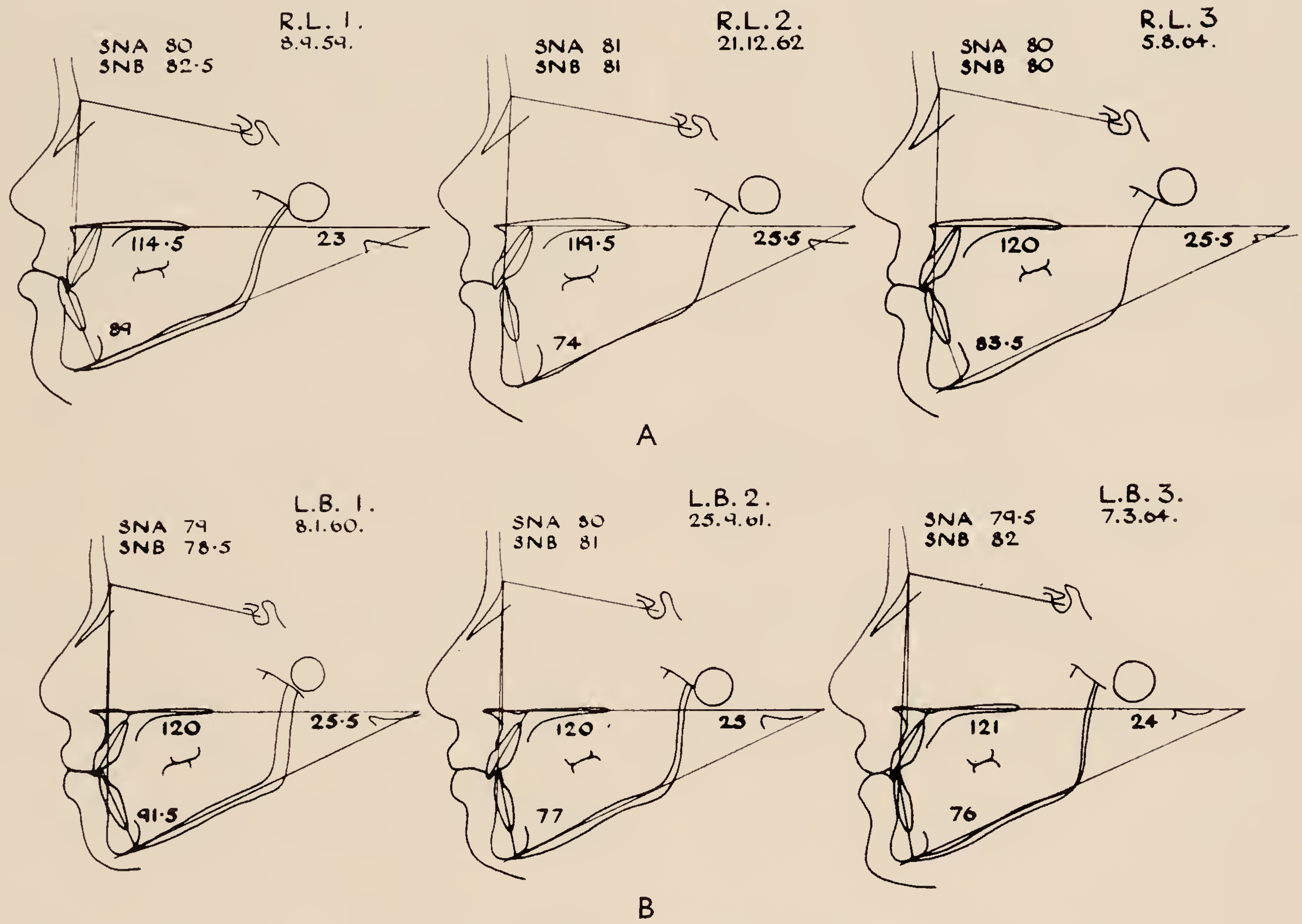

Fig. 4.—Tracings of lateral skull radiographs. A, *Case* R.L. B, *Case* L.B.

Summary

The first attempt at treatment took ten months and consisted of:—

1. One months' active treatment.
2. Nine months' combined active treatment and retention.

The second attempt at treatment took seven months.

COMMENTS

Providing uncertain co-operation does not cause confusion, these uncommon 'border-line' Class III cases can readily be recognized. A prolonged attempt to procline the upper incisors should be avoided as it will tend to result in depression of these teeth.

Cephalometric Analysis

Bearing in mind the limitations inherent in analyses based on tracings of lateral skull radiographs, there are, nevertheless, one or two features of these two cases that such an analysis serves to clarify (*Table I*).

Case R.L.

An analysis of the three lateral skull radiographs (in occlusion) taken on 8 September, 1959, 21 December, 1962, and 5 August, 1964 suggest that the original occlusion, with its displacing activity, was overclosed (Ballard, 1955). The photographs taken before treatment (*Fig.* 1A) illustrate the increased interocclusal clearance that was present. Again, it suggests that the orthodontic treatment to change the incisor relationship and thereby eliminate the mandibular displacement also resulted in correction of the overclosure as described by Parker (1960).

1. *Changes Directly Resulting from Orthodontic Treatment*

a. Immediate changes as shown by comparing the second with the first radiograph:—

i. $\underline{1|1}$ were proclined some 5° relative to the maxillary plane (Mx). Similarly, the angle between the labial face of $\underline{1|1}$ and the cranial base reference line, sella-nasion (SN plane), increased by 2·5°. (A line from nasion which is a tangent to the labial surface of the crowns of the upper central incisors is used for this.)

ii. $\overline{1|1}$ were retroclined some 15° relative to the mandibular plane (Md) appearing to tilt about a point approximately one-third of the length of the root from their apices to result in some labial apical movement. The angle between the sella-nasion plane and the labial faces of the crowns of $\overline{1|1}$ decreased by 3°, while that with their apices increased by 1° (in spite of the elimination of the mandibular displacement). The labial movement of the lower incisor apices is clearly

Table I.—Readings from Lateral Skull Radiographs (in Occlusion) before, soon after Displacement was eliminated, and Two or More Years later

	R.L.			L.B.		
	8 Sept., 59	21 Dec., 62	5 Aug., 64	8 Jan., 60	25 Sept., 61	7 Mar., 64
N-ANS	49 mm.	50 mm.	53 mm.	49 mm.	50 mm.	52 mm.
ANS-GN	55 mm.	62 mm.	63 mm.	55 mm.	56·5 mm.	58 mm.
Angle N-S-GN	64°	65·5°	66°	69·5°	68°	67°
Angle S-N-GN	83°	81°	80·5°	78°	80°	82°
Angle Mx-Md	23°	25·5°	25·5°	25·5°	25°	24°
Angle SN-GOGN	32°	35°	35°	36°	34°	33°
Angle ULS-Mx	114·5°	119·5°	120°	120°	120°	121°
Angle LLS-Md	89°	74°	83·5°	91·5°	77°	76°
Angle SNA	80°	81°	80°	79°	80°	79·5°
Angle SNB	82·5°	81°	80°	78·5°	81°	82°
Angle of convexity	−6°	0°	−2°	+1°	−4°	−9°
Angle SN-apices ULS	69°	70°	71°	70°	72°	73°
Angle SN-labial face ULS	82°	84·5°	84·5°	82·5°	84°	84·5°
Angle SN-apices LLS	77°	78°	76°	73°	77°	79°
Angle SN-labial face LLS	85°	82°	82°	80·5°	80·5°	81·5°
Angle SN-occlusal plane	23°	20°	20°	23·5°	23°	20·5°
ANS-tip of $\underline{1|1}$	23·5 mm.	24·5 mm.	25 mm.	25 mm.	26·5 mm.	26 mm.
Tip of $\overline{1|1}$-GN	36·5 mm.	39·5 mm.	39 mm.	32 mm.	33·5 mm.	34·5 mm.
Occlusal plane-Mx	16 mm.	18·5 mm.	19 mm.	17 mm.	18 mm.	20·5 mm.
Occlusal plane-Md	23·5 mm.	26·5 mm.	28 mm.	22 mm.	22 mm.	22 mm.

shown by superimposing on gnathion (GN) and the mandibular plane.

b. Further changes shown by comparing the third radiograph with the second radiograph:—

The upper and lower incisor crowns had not changed position relative to the cranial base as the angles between the labial faces of the upper and lower incisors and sella-nasion plane can be seen to have remained constant. However, there had been a lingual apical relapse of the lower incisors (2° in relation to sella-nasion plane) producing an uprighting relative to the mandibular plane of some 9·5°.

c. Overall changes as shown by comparing the third radiograph with the first radiograph:—

i. A proclination of some 5·5° of the upper incisors relative to the maxillary plane.

ii. A retroclination of some 5·5° of the lower incisors relative to the mandibular plane.

2. *Changes that are Associated with the Elimination of the Mandibular Displacement*

a. Change in SNA and SNB angles:—

There was a reduction in the angle SNB (1·5°) with angle SNA remaining unchanged.

b. Change in the Y-axis:—

The Y-axis, namely angle N-S-GN, increased (1·5°) and the angle S-N-GN reduced (2°), both indicating that gnathion had moved back relative to the sella-nasion plane.

c. Change in the angle of convexity (defined as the complement of the angle N-A-Po, and is positive if A point is in front of pogonion (Po), and negative if behind):—

The angle of convexity became less negative (−6° to 0°).

3. *Changes that Suggest the Correction of an Overclosure*

a. Face height changes:—

The distance anterior nasal spine (ANS) to gnathion showed a much greater increase in comparison to that shown by nasion to anterior nasal spine between the first and second radiographs (7 mm. compared to 1 mm.). This cannot be accounted for by normal growth as an integral part of a regular growth pattern, but rather suggests a relatively excessive growth in the lower face height correcting a mandibular overclosure. The vertical development of the dento-alveolar structures to account for this consisted of:—

1 mm. increase from ANS to incisal tips of $\underline{1|1}$.

3 mm. increase from GN to incisal tips of $\overline{1|1}$.

2·5 mm. increase on the perpendicular from Mx plane to distal cusp tip $\underline{6|6}$.

3 mm. increase on the perpendicular from Md plane to distal cusp tip $\underline{6|6}$.

These relative differences in degree of vertical development explain the reduction in incisor overbite observed (particularly the relative lack of vertical development of the upper incisors) and account for the change in angulation between the occlusal plane (the line joining the incisal tips of $\underline{1|1}$ and the distal cusp tips of $\underline{6|6}$ was used as the occlusal plane) and the sella-nasion plane (a decrease of 3°). The vertical development between the second and third radiographs can be seen from the table.

b. Change in the maxillary-mandibular-planes angle (Mx-Md):—

Over this same period this angle had opened 2·5°, and the angle between the mandibular and the sella-nasion planes increased by 3°, possibly as the result of the dento-alveolar growth correcting the overclosure.

Case L.B.

An analysis of the three lateral skull radiographs (in occlusion) taken on 8 January, 1960, 25 September, 1961, and 7 March, 1964, show a pattern of growth in which the horizontal component of mandibular growth is more marked than the vertical, resulting in an increasing mandibular prognathism.

1. *Changes Resulting from Orthodontic Treatment*

a. Immediate changes, comparing the second radiograph to the first radiograph:—

$\overline{1|1}$ were retroclined some 14·5° relative to the mandibular plane. By superimposing on gnathion and the mandibular plane, the tilting can be seen to have taken place about a point close to their apices. The angle between sella-nasion plane and the labial face of $\overline{1|1}$ remained unchanged. No orthodontic forces were applied to the upper incisors, and there was no change in their position in relation to the maxillary plane and an increase of 1·5° in the angle between their labial faces and the sella-nasion plane.

b. Further changes comparing the third radiograph with the second radiograph:—

No relapse of the lower incisor retroclination occurred and, if anything, there was a tendency for further lingual tilting to occur. In fact, no appreciable change in the angulation of either the lower or the upper incisors occurred.

2. *Changes Resulting from the Growth Pattern*

a. An increase in mandibular prognathism as shown by:—

i. Change in angles SNA and SNB:—

Increase in the angle SNB (3·5°) with SNA remaining the same.

ii. Change in the Y-axis:—

The angle N-S-GN steadily decreasing (2·5° in all) and the angle S-N-GN increasing (4° in all).

iii. Change in the angle of convexity:—

The change from a slightly positive reading to an increasingly negative one (+1 to −9).

iv. Maxillary-mandibular-planes angle:—

The more marked horizontal component of mandibular growth may account for the decreasing maxillary-mandibular-planes angle (1·5°) and the tendency to a steady reduction in the angle between the mandibular and sella-nasion planes (3°).

b. Absence of any element of overclosure:—

The regular increases in the measurements nasion to anterior nasal spine and anterior nasal spine to gnathion and the relation of these increments to each other preclude any possibility of an overclosure of the mandible being present before orthodontic treatment was carried out. *Case* L.B. illustrates that where the displacing activity is slight, overclosure does not occur.

c. The vertical development of the dento-alveolar structures:—

Over this period of some three years the vertical development of the incisors and molars followed a regular pattern with the following exceptions:—

i. Vertical development of the upper incisors (measured from ANS to incisal tips $\underline{1|1}$) did not occur between the second and third radiographs.

ii. No vertical development of the lower molars relative to the mandibular plane occurred during the entire period of these observations. Both (i) and (ii) account for the occlusal plane tipping with the resulting decrease in angle between the occlusal and the sella-nasion planes (3°). The relatively greater vertical development in the molar region compared to that in the incisor region accounts for the reduction in incisor overbite.

3. *Explanation and Prognosis*

The increase in mandibular prognathism explains why the marked lower incisor retroclination produced by orthodontic treatment has remained stable. The apices of the lower incisors have been carried forward by the mandibular growth (the angle between the apices of the lower incisors and the sella-nasion plane having steadily increased some 6°) while their crowns appear to have been restrained by their relationship with the upper incisors which are presumably held in a position of soft-tissue balance (the angle of the apices of the upper incisors to the sella-nasion plane having increased only 3°, and the angle between the labial face of the upper incisors and the sella-nasion plane some 2° with a 1° increase in their angulation relative to the maxillary plane. The angle between the labial faces of the lower incisors and the sella-nasion plane having increased only 1° over this period).

It can be visualized that, assuming the same propensity for vertical development of the lower incisors, this growth pattern has the effect of reducing the incisor overbite. If this growth trend continues and sufficient growth occurs, there would appear to be a definite possibility of a change occurring in incisor relationship to one of reverse incisor overbite and overjet. This case serves to illustrate that an unfavourable growth pattern is an important cause of relapse in Class III cases, as stated by Hopkin (1962).

Acknowledgements

I would like to thank Professor C. F. Ballard and Dr. J. R. E. Mills for permission to publish these cases and for their help and comments. I am grateful to the Photographic Department of the Eastman Dental Hospital for preparing the photographs.

REFERENCES

Ballard, C. F. (1955), *Dent. Practit.*, **6**, 80.

Fletcher, G. G. T. (1958), *Trans. Brit. Soc. Orthodont.*, 31.

Hopkin, G. B. (1962), *Ibid.*, 130.

Parker, C. D. (1960), *Dent. Practit.*, **10**, 59.

DISCUSSION

The President remarked that he noticed Mr. Brenchley had extracted $\overline{4|4}$ to allow the lower labial segment to collapse lingually. He wondered whether in fact they would do so, since presumably they were in a position of muscular balance.

Mr. M. L. Brenchley said presumably they had moved lingually to some extent, since they were retroclined 14·5° in the final radiograph.

Dr. J. R. E. Mills said that over-closure in Class III cases had been accepted by many people. In two of the photographs shown there was a large space between the occlusal position and the rest position. There were two possible explanations, or a combination of them. The occlusal position could be over-closed or the rest position could be over-opened. Where you had patients who had a mild Class III skeletal pattern, in the rest position their front teeth got in the way and therefore they adopted an abnormal position with their teeth edge-to-edge. He was not going to be dogmatic, but his impression was that this over-closure, if it existed at all, was very much less common than was believed.

Mr. M. L. Brenchley said that Dr. Mills might well be right in general, but in the first case he could not see any explanation other than a correction of over-closure. The distance ANS-GN had increased by 7 mm. between the first two radiographs, although admittedly it tended to balance itself out to a certain extent later.

Mr. N. L. Hill said that the trouble with this type of case was the large lower arch. The extraction of the first premolars caused quite a lot of space, and he asked if Mr. Brenchley ever removed the lower first molars where he only wanted a slight retraction of the lower incisors. In a particular case three years ago he remembered the boy's own dental surgeon removed a left lower first molar and with this treatment the lower incisors fell back, giving a very nice result.

Mr. Brenchley said he had a very strong feeling against removing lower first molars unless it was possible to remove them early at the age of 8½ or 9 years. If they were extracted later than that the position of lower second premolar and second molar was often such that a fixed appliance was needed to correct them.

Mr. H. G. Watkin asked if he made any enquiries as to the hereditary history of the patient.

Mr. Brenchley said he had not in fact checked this, but he saw one parent in each case, neither of whom was prognathic.

OBSERVATIONS ON THE TREATMENT OF CLEFT LIP AND PALATE

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THE very early treatment of cleft lip and palate cases, usually known as presurgical dental orthopaedic treatment, was pioneered by McNeil (1954), of Glasgow Dental Hospital, and later developed by Burston (1958), of Liverpool.

The new technique aroused considerable interest as well as controversy, mainly because, when it was first evolved, many people thought it was capable of producing non-surgical union of the soft tissues across the cleft without the need to resort to surgery.

Despite this being subsequently disproved, interest in presurgical treatment was maintained and even increased, because its adherents claimed it conferred the following benefits:—

1. The improved alinement of the maxillary segments prior to surgery would facilitate the segments forming a butt joint after lip repair, rather than overlapping to produce a contracted upper arch.
2. Because the width of the palatal and alveolar clefts was reduced by treatment, surgery would be less severe, i.e., there would be less need for extensive freeing of the soft tissues in order to obtain a tension-free lip repair. It might be expected, therefore, that there would be less interference with maxillary growth later.
3. Because lip repair was not usually undertaken until the child was about six months old it was easier for the surgeon to produce a slack lip with good aesthetics, as the tissues were larger and easier to handle.
4. The appliance aided feeding.
5. The mother derived considerable psychological benefit from the treatment, which could be regarded as a form of social medicine. The more relaxed atmosphere in the home deriving from this might be considered to benefit the entire family.

Despite the enormous interest aroused in presurgical treatment culminating in the International Symposium on Cleft Lip and Palate (1964) held at the Zürich University Dental Institute, very little evidence has been produced to support the above contentions, partly due to the difficulty of obtaining control cases.

Pruzansky (1964) has been highly critical of the advocates of presurgical treatment for this lack of scientific evidence to support their claims.

In the Birmingham region, presurgical dental orthopaedic treatment has been undertaken for the past six years; the first four cases treated were demonstrated at the Country Meeting of the British Society for the Study of Orthodontics in May, 1961 (Huddart, 1961).

In view of the controversy about the long-term benefits of such treatment, these original four cases are presented again, having now reached five years of age.

For comparison, details of four other cases who had no presurgical treatment are also described.

In all, the number of unilateral and bilateral complete clefts which have so far received presurgical treatment in this unit, is about one hundred and fifty. It is hoped to carry out further and more extensive comparisons between these and untreated cases in due course.

CASE REPORTS

Case 1

Paul W., born 1 October, 1959. Complete bilateral cleft lip and palate with considerable protrusion of the premaxilla (*Fig.* 1).

Demonstration presented at the Country Meeting held in Birmingham on 1 May, 1965.

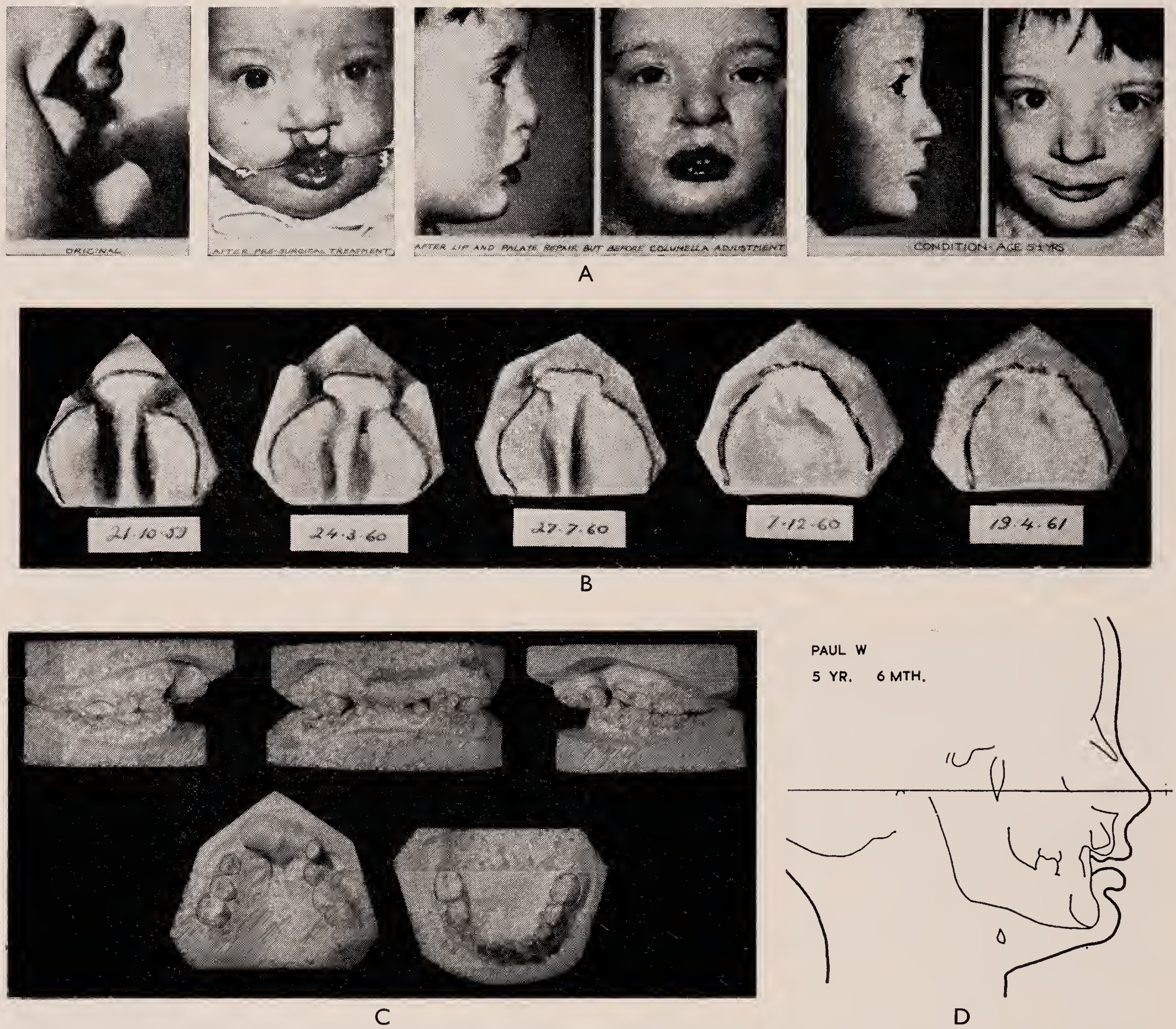


Fig. 1.—Paul W., born 1.10.59. Lip repaired 23.2.60, aged 4¾ months. Palate repaired 17.10.60, aged 12½ months. Columella advanced 14.2.63, aged 3 years 4 months. A, Facial photographs, B, Maxillary models. C, Occlusion in April 1965, aged 5 years 6 months. D, Cephalometric tracing, aged 5 years 6 months.

21 October, 1959: Presurgical dental orthopaedic treatment commenced and first appliance inserted.

24 October, 1959: Strapping applied.

First Operation (J.F.N.)

23 February, 1960: Linear repair of both sides of the lip and both nostril floors with 'Z' closure of the free border.

Presurgical dental orthopaedic appliances were fitted again after lip repair, but these had little effect upon the position of the segments.

Second Operation (J.F.N.)

17 October, 1960: Repair of palate by four flap Wardill-Kilner technique. A residual fistula was present in the anterior hard palate initially, but later the edges of this approximated and the opening became only a potential one.

Third Operation (J.F.N.)

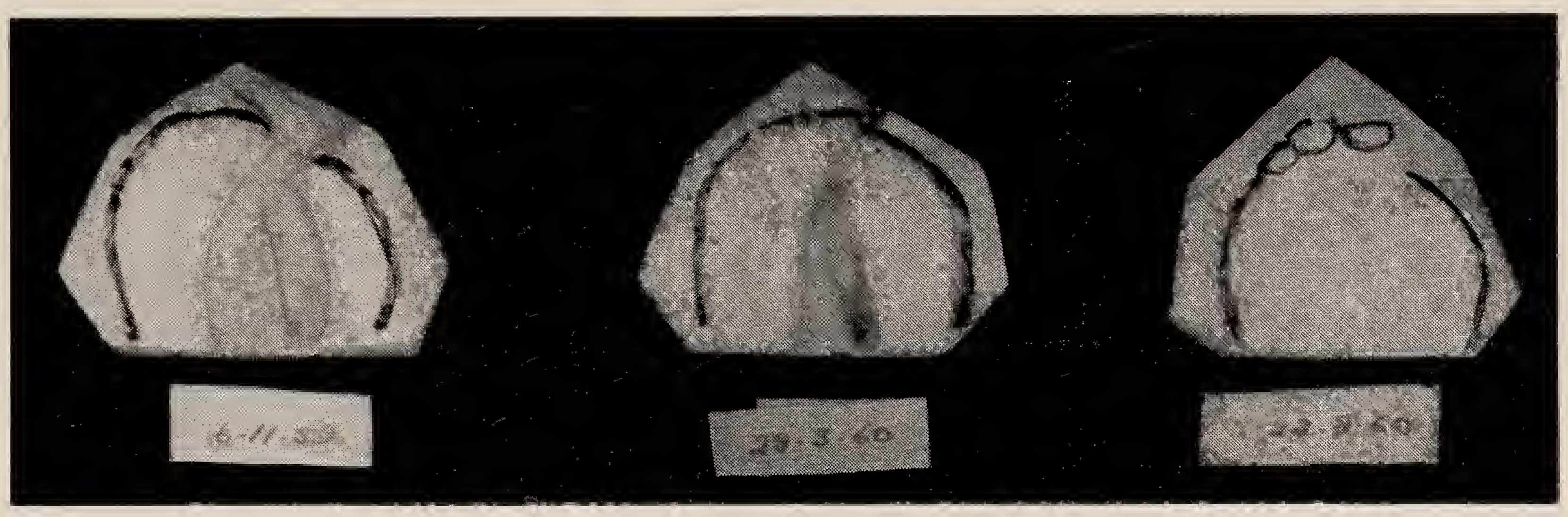
14 February 1963: Advancement of columella with small full-thickness skin-graft from left postauricular region to midline of lip (*Fig.* 1A).

Comments

The occlusion at the age of 5 years 6 months is quite reasonable (*Fig.* 1C, D), although the right buccal segment is somewhat medially placed. There has also been a slight fall in of the anterior end of the left buccal segment relative to the lower arch, but this is not considered serious. Relative to the buccal segments the premaxilla is at too low a level, and, in consequence, a very deep overbite was present initially. Because of trauma to the labial gingival margins of the lower incisors, three upper deciduous incisors were removed in January, 1964, to eliminate this.

The vertical discrepancy between the height of the premaxilla and the height of the buccal segments does seem to be decreasing when the models of December, 1960, and April, 1965, are compared, and future changes in this relationship

A



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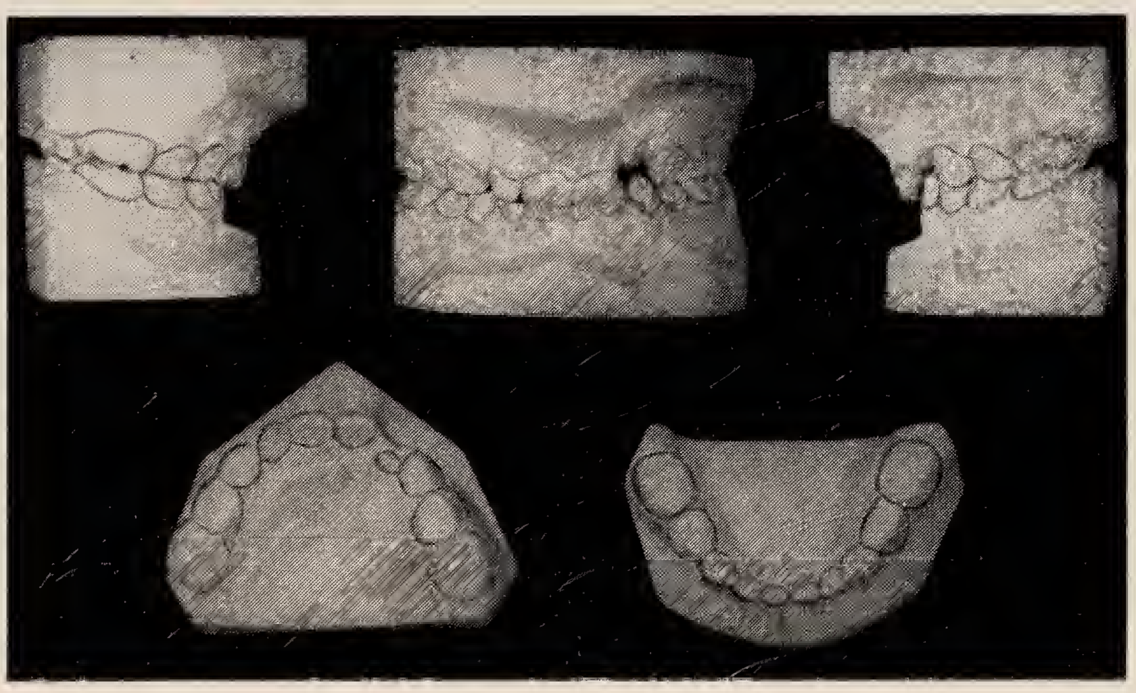

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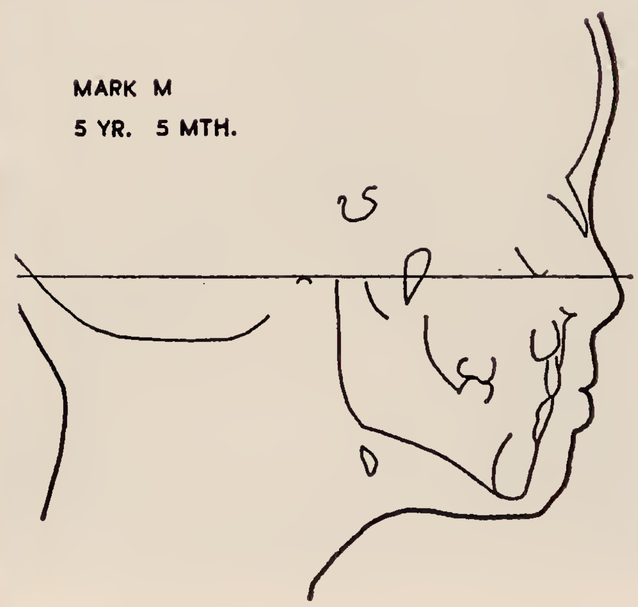


D

Fig. 2.—Mark M., born 1.11.59. Palate and left lip repaired simultaneously 31.5.60, aged 7 months. Right lip repaired 18.8.64, aged 4 years 9 months. A, Facial photographs, B, Maxillary models. C, Occlusion in April, 1965, aged 5 years 5 months. D, Cephalometric tracing, aged 5 years 5 months.

will be watched with interest. His speech shows certain faults, but the prognosis is considered to be good.

Case 2

Mark M., born 1 November, 1959. Complete cleft of left lip, alveolus, and palate. Partial cleft right lip and palate (*Fig.* 2).

6 November, 1959: Presurgical treatment commenced and first appliance inserted.

10 November, 1959: External strapping applied.

First Operation (Mr. O. T. Mansfield)

31 May, 1960: Simultaneous linear repair of left lip and V-Y repair of palate. Right partial lip cleft unrepaired at this stage.

No dental orthopaedic treatment was undertaken after this stage.

Second Operation (Mr. O. T. Mansfield)

18 August, 1964: Linear repair right partial cleft lip (*Fig.* 2A). Closure of small anterior palatal fistula.

Comments

At the age of 5 years 5 months, the maxillary development, general dental condition, arch alinement, and occlusion are excellent (*Fig.* 2C, D).

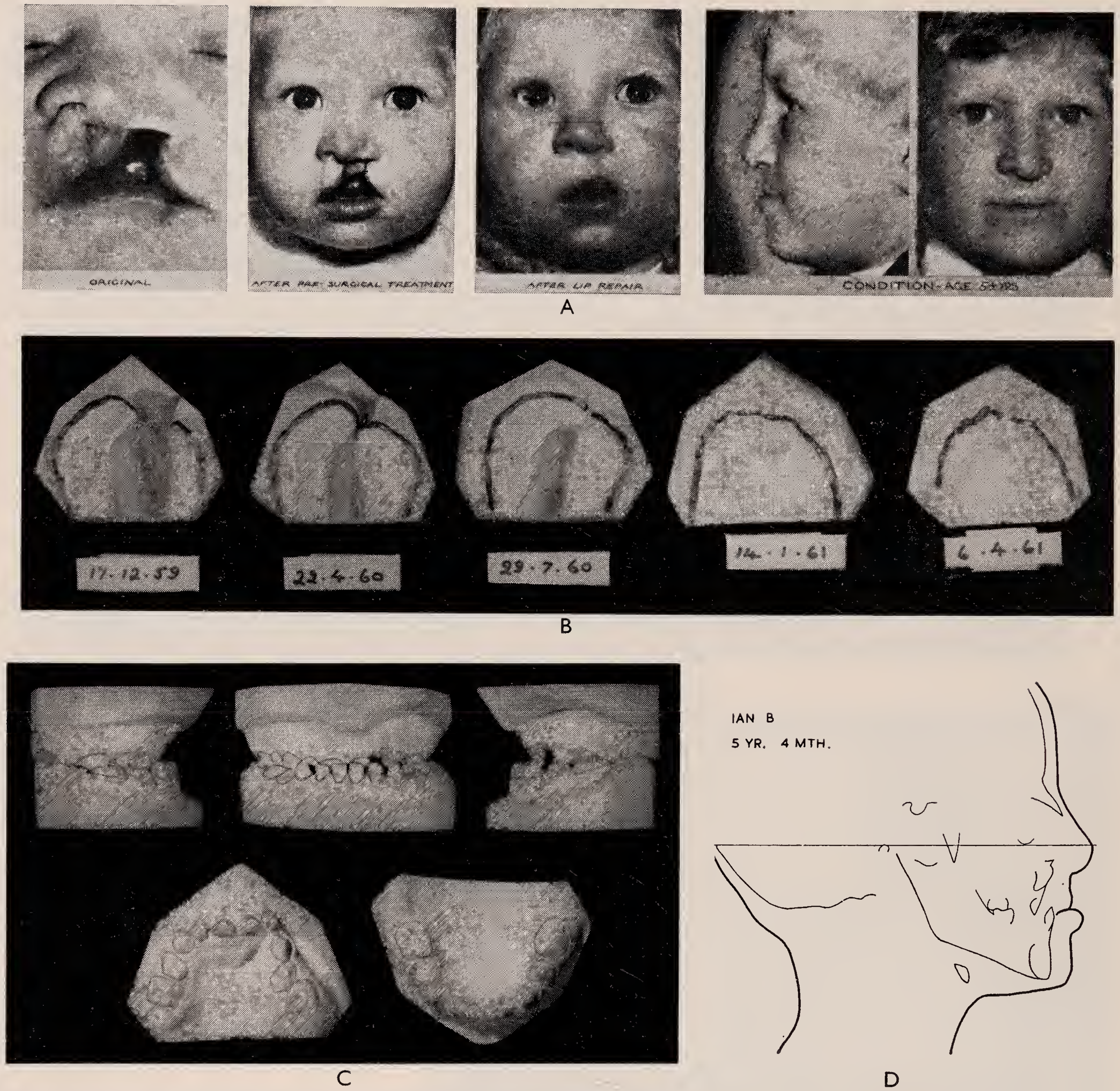


Fig. 3.—Ian B., born 3.12.59. Lip repaired 20.6.60, aged 6½ months. Palate repaired 3.11.60, aged 11 months. A, Facial photographs. B, Maxillary models. C, Occlusion in April, 1965, aged 5 years 4 months. D, Cephalometric tracing, aged 5 years 4 months.

The only malocclusion present is the palatal displacement of |B. The good arch alinement and occlusion may possibly be due to the butt joint obtained by the presurgical treatment prior to surgical closure of the lip and palate (*Fig.* 2B). The lip after repair on 31 May, 1960, was very slack, however, because the right partial cleft lip was not touched, and the absence of any constricting force by the repaired lip may also be a factor in the absence of palatal constriction in this case.

Speech is perfect, but it is expected that slight adjustment of the lip margin may be necessary later.

Case 3

Ian B., born 3 December, 1959. Complete unilateral cleft of left lip, alveolus, and palate (*Fig.* 3).

17 December, 1959: Presurgical treatment commenced and first appliance inserted. The external strapping was applied at the same time.

First Operation (J.F.N.)

20 June, 1960: Repair of left cleft lip by Tennison method and of nostril floor.

Dental orthopaedic appliances were inserted after operation, but these had no effect as the patient would not tolerate them.

Second Operation (J.F.N.)

3 November, 1960: Primary four flap Wardill-Kilner repair of palate.

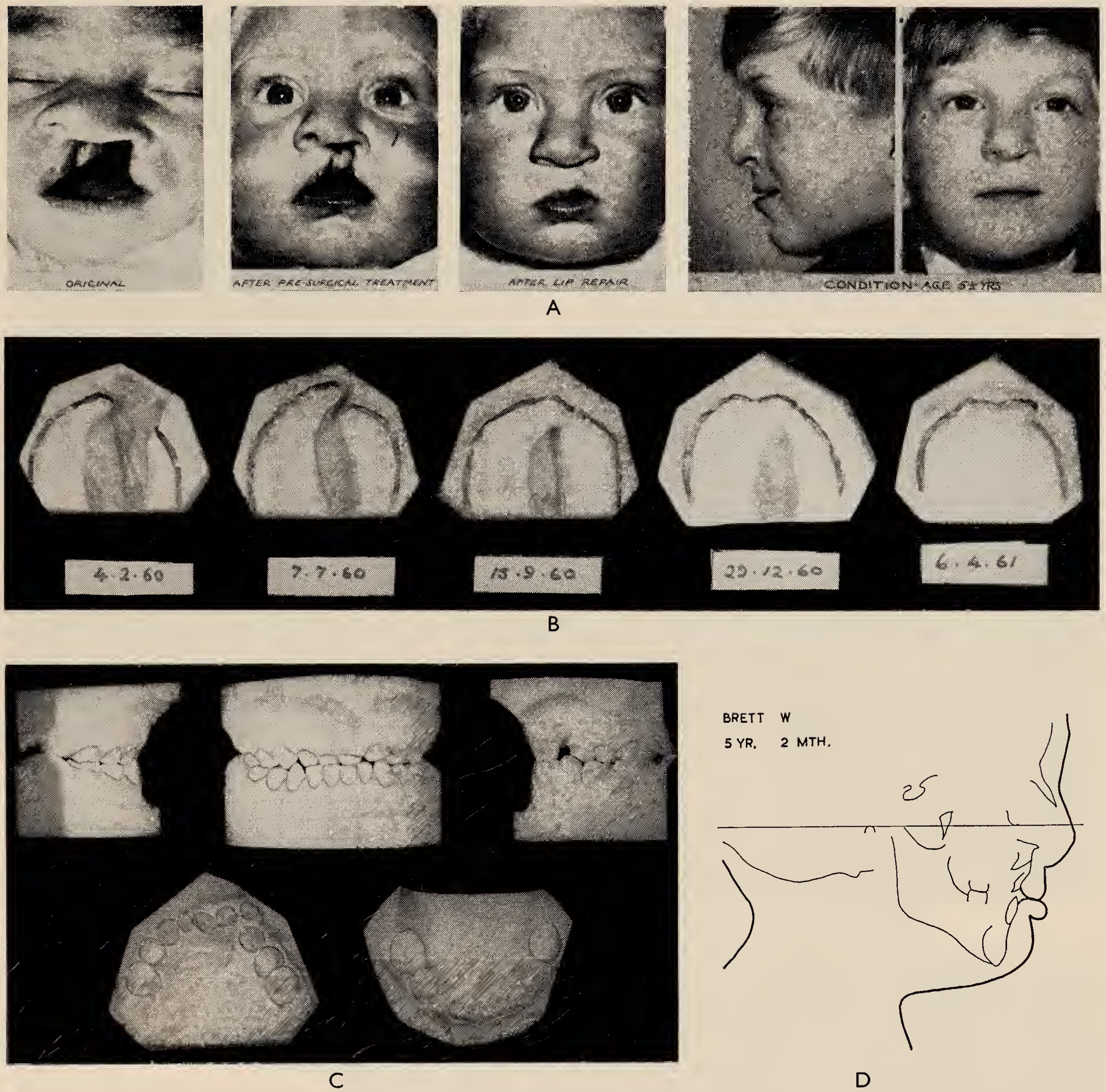


Fig. 4.—Brett W., born 27.1.60. Lip repaired 28.7.60, aged 6 months. Palate repaired 29.12.60, aged 11 months. A, Facial photographs. B, Maxillary models. C, Occlusion in April, 1965, aged 5 years 3 months. D, Cephalometric tracing, aged 5 years 3 months.

Comments

The general dental condition at the age of 5 years 4 months is good and the alinement of the segments in the upper arch is also satisfactory (*Fig*. 3C). At the time of palate repair in November, 1960, $\underline{|A}$ was inside the bite and an appliance was inserted to correct this in January, 1961. The patient would not wear this, however, and the appliance was eventually withdrawn.

By December, 1961, $\underline{|A}$ and $\overline{BA|}$ were inside the bite, and since then the Class III incisor relationship has become progressively worse. The reverse overjet was −3·8 mm. in May, 1963, −4 mm. in December, 1963, −4·9 mm. in July, 1964, and −6 mm. in April, 1965 (*Fig*. 3D).

This patient's father has a Class III malocclusion and there is, therefore, a possibility that this may be an example where there is a cleft palate deformity superimposed upon a basal Class III condition.

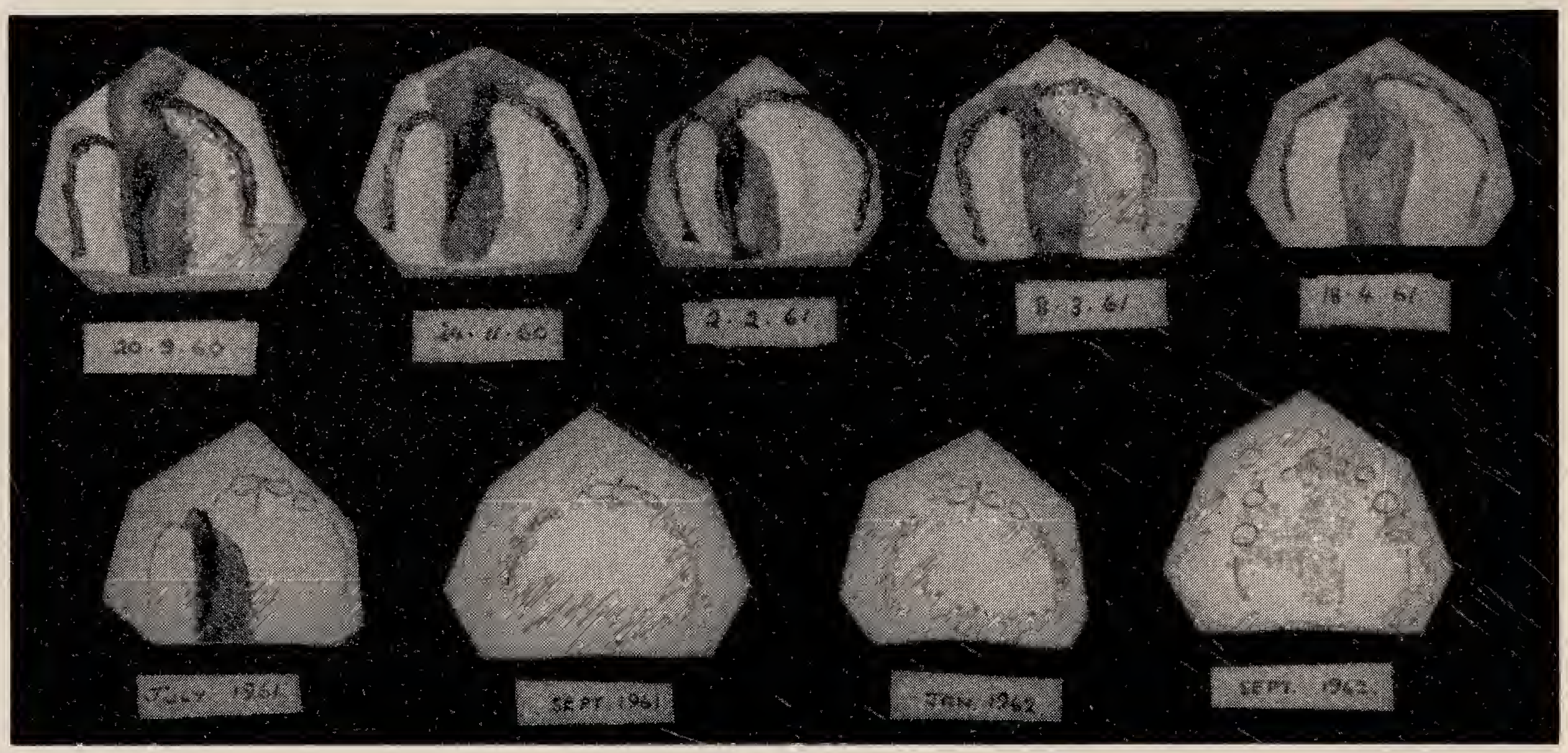
Speech is good.

Case 4

Brett W., born 27 January, 1960. Complete unilateral cleft lip and palate (*Fig*. 4).

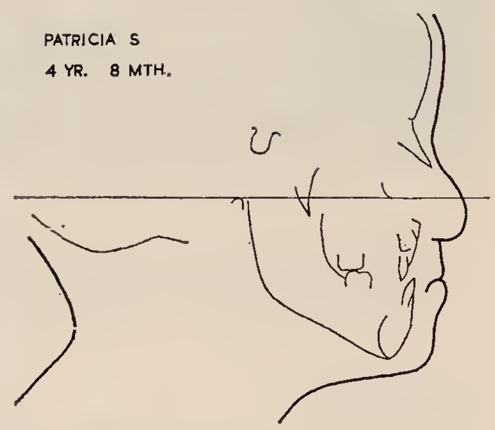
4 February, 1960: Presurgical treatment commenced and appliance inserted. External strapping applied two days later.

A



B

C



D

Fig. 5.—Patricia S., born 4.8.60. Control Case. Lip repaired 24.11.60, aged $3\frac{3}{4}$ months. Palate repaired 3.7.61, aged $7\frac{1}{4}$ months. A, Facial photographs. B, Maxillary models. C, *Upper*, occlusion of mother. *Lower*, occlusion of Patricia S. in April, 1965, aged 4 years 8 months. D, Cephalometric tracing, aged 4 years 8 months.

15 July, 1960: A stabilizing appliance to prevent postoperative collapse of the lesser segment was inserted.

First Operation (J.F.N.)

28 July, 1960: Primary repair of lip by Tennison method and of nostril floor.

18 August, 1960: Stabilizing appliance re-inserted.

15 September, 1960: A stimulation appliance to try to reduce the width of the palatal cleft was inserted, but whether this was of value is uncertain.

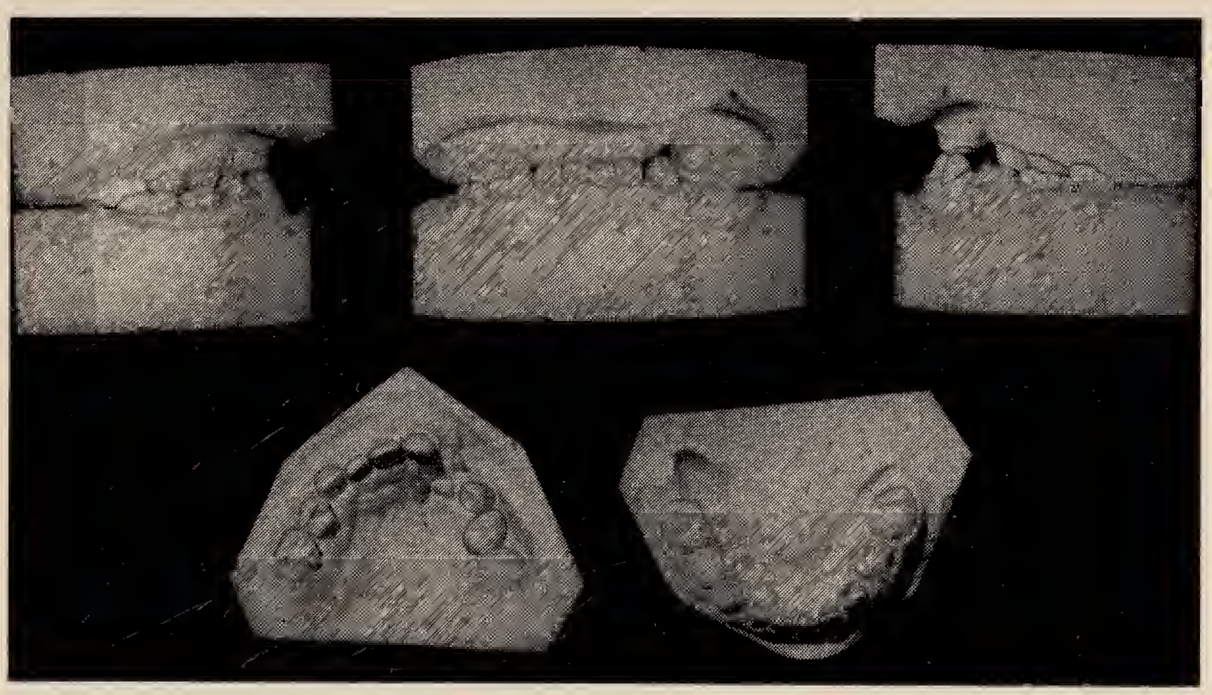
Second Operation (J.F.N.)

29 December, 1960: Primary four flap Wardill-Kilner repair of palate.

No appliances were fitted after palate repair.

A

B



C

Fig. 6.—Linda B., born 5.1.61. Control Case. Lip repaired 8.5.61, aged 4 months. Palate repaired 16.4.62, aged 1 year 3 months. A, Facial photographs. B, Maxillary models. C, Occlusion April 1965, aged 4 years 3 months.

Comments

The general dental condition at the age of 5 years 3 months is good (*Fig*. 4C). There is a slight Class III incisor relationship, and a little contraction of the upper arch with $\underline{|CD}$ somewhat inside the lower teeth. The occlusion appears to be remaining reasonably stable and is not becoming progressively more Class III as in *Case* 3. Similarly, alinement of the segments of the upper arch is also staying reasonably stable.

His speech is good.

Case 5: Control Case—No Presurgical Treatment Undertaken.

Patricia S., born 4 August, 1960. Complete cleft of the right lip, alveolus, and palate (*Fig*. 5).

First Operation (J.F.N.)

24 November, 1960: Primary repair of lip by Tennison method and of nostril floor.

Second Operation (J.F.N.)

3 July, 1961: Primary four flap Wardill-Kilner repair of palate.

Comments

At the age of 4 years 8 months, there is good alinement of the segments of the upper arch, with a small residual gap in the alveolar region. A mild Class III occlusion is present with the

A

B

C

Fig. 7.—Trevor C., born 21.2.62, Control Case. Lip repaired 19.7.62, aged 5 months. Palate repaired 26.9.63, aged 1 year 7 months. A, Facial photographs. B, Maxillary models. C, Occlusion April, 1965, aged 3 years 2 months.

upper incisors just inside the bite. The anterior end of the lesser segment is also slightly inside the lower arch (*Fig*. 5C).

The general dental condition is good and the speech is also good.

The series of maxillary models (*Fig*. 5B) available shows a wide cleft to start with, but considerable movement of the segments occurred during the first two months after lip repair. After this, very little further movement occurred until the palate was repaired. An unusual feature is the persistence of the gap in the alveolar ridge in spite of early lip repair. The maxillary arch is well shaped, however. Some reduction in the palatal width was noted during the first two months after palate repair, but after this very little change occurred.

It would appear in this case that the lesser segment was well placed initially. Even so, the cleft was wide. The lack of postoperative collapse may also be due to inherited factors because the mother had a broad upper arch with

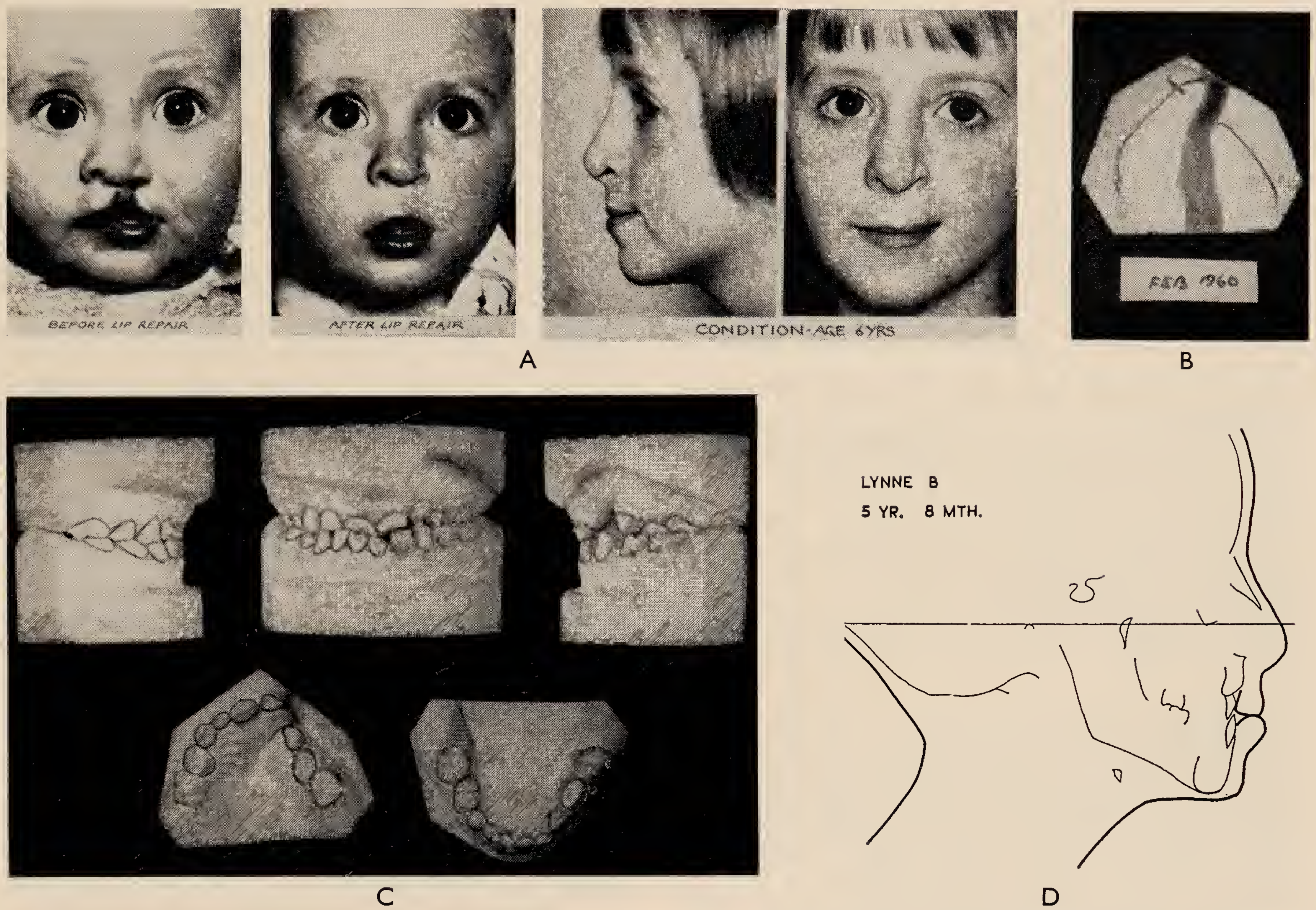


Fig. 8.—Lynne B., born 8.7.59. Control Case. Lip repaired 18.2.60, aged 7¼ months. Palate repaired 16.6.60, aged 11¼ months. A, Facial photographs. B, Maxillary model (pre lip repair), C, Occlusion, April, 1965, aged 5 years 9 months. D, Cephalometric tracing, aged 5 years 9 months.

widely spaced teeth and a Class I occlusion (*Fig.* 5C).

Case 6: Control Case—No Presurgical Treatment Undertaken.

Linda B., born 5 January, 1961. Complete unilateral cleft of the left lip, alveolus, and palate, with a soft-tissue bridge in the alveolar region. The lesser segment was well placed forwards and laterally (*Fig.* 6).

First Operation (J.F.N.)

8 May, 1961: Primary repair of lip by Tennison method and of nostril floor.

Second Operation (J.F.N.)

16 April, 1962: Primary four flap Wardill-Kilner repair of palate.

Comments

The occlusion at the age of 4 years 3 months is a mild Class III, and there has been slight fall in of the lesser segment relative to the lower arch (*Fig.* 6C). Speech is promising.

The series of models available starting at fifteen days and taken at monthly intervals until the lip was repaired at four months show considerable reduction in the width of the alveolar cleft (*Fig.* 6B).

After lip repair the segments came into a good position and remained there. This case demonstrates the spontaneous improvement which may occur prior to lip repair and which might have been ascribed to presurgical treatment, had this been undertaken. Furthermore, after lip repair and the attainment of a butt joint the alinement of the maxillary segment remained stable.

Case 7: Control Case—No Presurgical Treatment Undertaken.

Trevor C., born 21 February, 1962. Bilateral cleft lip (right side complete, left side incomplete). Unilateral right cleft alveolus, wide bilateral cleft palate. Lesser segments well placed (*Fig.* 7).

First Operation (J.F.N.)

19 July, 1962: Primary linear repair of bilateral cleft lip and of right nostril floor.

Second Operation (J.F.N.)

29 September, 1963: Primary four flap Wardill-Kilner repair of palate.

Comments

The maxillary models show a wide original cleft with a well-placed lesser segment moving into good alinement after lip repair and remaining there (*Fig.* 7B).

The models of the occlusion at the age of 3 years and 2 months show the upper

incisors in edge-to-edge occlusion with the lower ones. The occlusion of the buccal teeth is good (*Fig.* 7C). A supernumerary tooth has erupted palatally to |A. It is too early to say at present whether the incisors will remain in an edge-to-edge relationship or whether the uppers will fall completely inside the lowers. It must be noted, however, that at the age of 8 months, after lip repair, the upper centre line was displaced to the left and there was a satisfactory overbite of the incisors.

Case 8: Control Case—No Presurgical Treatment Undertaken.

Lynne B., born 8 July, 1959. Complete unilateral cleft of lip, alveolus, and palate. Lesser segment placed medially (*Fig.* 8).

First Operation (J.F.N.)

18 February, 1960: Primary repair of lip by Tennison method and of nostril floor.

Second Operation (J.F.N.)

16 June, 1960: Primary four flap Wardill-Kilner repair of palate.

Comments

The maxillary model dated 18 February, 1960, taken prior to lip repair showed a medially placed lesser segment (*Fig.* 8B). After lip repair there was a contraction of the upper arch with the lesser segment inside the greater. Presurgical treatment *might* have avoided this.

The occlusion at 5 years 9 months shows the upper incisors inside the bite and there has been fall in of the lesser segment with |CDE inside the lower arch. The occlusion of EDC| is normal, however (*Fig.* 8C).

The general dental condition is good and speech is also good.

This is one of very few cases showing marked collapse of the upper arch. Possibly forced maxillary expansion with a secondary stabilizing bone-graft might be considered eventually to correct this.

DISCUSSION

No definite conclusion can be drawn by a comparison of the two groups of cases, but it is evident that a good occlusion and arch form can be obtained at the 5-year-old level, with or without presurgical treatment.

It is suggested that a good final arch alinement may depend on the original position of the lesser segment in a unilateral case. Probably *Case* 5 (control) would not have benefited by presurgical treatment, but, on the other hand, *Case* 8 (control) might well have done so.

Case 3 illustrates that good arch alinement does not really imply good arch relationship; the maxillary arch is well shaped, but smaller than the mandibular arch, with resulting Class III occlusion. Indeed, this case which showed the most marked maxillary growth deficiency was one which had had presurgical treatment. The question arises whether this Class III malocclusion could have been avoided by early bone grafting. Alternatively, is secondary expansion and bone grafting justifiable in a case such as this with an arch which is well shaped but too small?

In the bilateral case (*Case* 1), there is a premaxilla which is anteroposteriorly well placed, but too low in the vertical plane. A satisfactory means of avoiding this by presurgical treatment has not been evolved. In view of the present interest in primary bone grafting, we feel it is pertinent to ask what would happen if early bone grafting were carried out with the premaxilla in this low position.

With regard to feeding and the psychological effect on the mother, presurgical treatment does appear to be beneficial. It has been noted, however, in some cases the child will feed almost as well using a large hole in the teat and no appliance, although when this is done there is sometimes prolonged ulceration on the underside of the nasal septum.

The peace of mind of the mother appears to depend not so much on the presurgical treatment as on her ability to discuss her problems and the future treatment of the child on frequent occasions with a member of the Plastic Unit. This appears to be particularly important in the first few days after the child is born. It is advice and encouragement at this stage which appears to be so much appreciated by parents, paediatricians, and social workers.

REFERENCES

Burston, W. R. (1958), *Trans. Brit. Soc. Orthodont.*, 41.

Huddart, A. G. (1961), *Ibid.*, 107.

International Symposium on Cleft Lip and Palate (1964), *Early Treatment of Cleft Lip and Palate* (ed. Hotz, R). Zürich: Huber.

McNeil, C. K. (1954), *Oral and Facial Deformity*, London: Pitman.

Pruzansky, S. (1964), *Cleft Palate Journal*, **1**, 164.

A NEW MATERIAL FOR ORTHODONTIC MODELS

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STUDY MODELS

STUDY models are widely used as routine records for orthodontic patients and are also used as teaching aids in dental schools. According to White, Gardiner, and Leighton (1957):—

1. They enable the occlusion to be viewed from every aspect.
2. They enable accurate measurement to be made on the dental arches.
3. Later when the patient is under treatment, the original models demonstrate progress to the operator, parents, and patient.
4. Should the patient move to another district, models will help the second practitioner to understand the patient's original condition.

Since the introduction of the National Health Service, study models of cases being treated have to be sent to the Dental Estimates Board.

Study models are usually made from either plaster-of-Paris or stone plaster. Models made from these materials break easily, and in use they tend to become dirty and abraded. Acrylic models have been used in cases which are of some particular significance or where models are used as a teaching aid (Morrant, 1953). While acrylic models are aesthetically extremely good they are expensive to produce.

A survey was made of alternative materials which would produce strong, durable, and inexpensive study models for teaching purposes. Such models would also be of value for recording special cases, as, for example, the infant cleft palate patient who may be under orthodontic supervision for about 20 years. Since it was a principle requirement that the material should require only equipment normally found in a dental laboratory, it was decided that polyurethane foam seemed feasible.

POLYURETHANE FOAM

Polyurethane foams have been applied in many different fields, for example, they are widely used as an insulating material and also in the construction of prostheses. There are a number of different types which can be classified, however, as either rigid or flexible. For use in dental models it was felt that the rigid foam would be preferable. Rigid foam systems were available in high- and low-density foams. Initially, low-density foams were tried and found to have inadequate strength. Thereafter, experiments were concentrated on the high-density foams which cover a range of 4 lb. per cu. ft., running up to 20 lb. per cu. ft. They are light, and have considerable mechanical strength which increases with the density.

The foam is produced by mixing liquid components which react chemically. Each of the two liquids in the system is stable if stored correctly and will remain stable until it is mixed with the other. On mixing, there is a chemical reaction and heat and carbon dioxide are produced. Consequently, the system which began as two separate liquids is transformed into a stable solid polyurethane foam.

If the material is inserted into a mould at the fluid stage a model can be produced.

MATERIALS

A suitable, almost white, material was found in the Spandofoam 400 series*. Other commercial materials with similar characteristics would be expected to give similar results.

The Spandofoam P.E. 400 W series is a two component polyether-based polyurethane system which will produce a rigid foam. The density can be varied according to the formulation, and foams with a density above 4 lb. per cu. ft. have good mechanical strength with low creep characteristics. The rigid foam is produced by the liberation of carbon dioxide formed by the reaction of isocyanate with water. When properly mixed and poured into a cavity, the liquid composition expands to fill the void space and cures to rigid foam. If this is an enclosed cavity and the proportions are correctly judged, a model can be produced which has a hard external skin and honeycombed interior.

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*Obtainable from: The Baxenden Chemical Co., Ltd., Paragon Works, Baxenden, Nr. Accrington, Lancashire.

Demonstration presented at the Country Meeting held in Birmingham on 1 May, 1965.

The two components of the system are:—

Component A

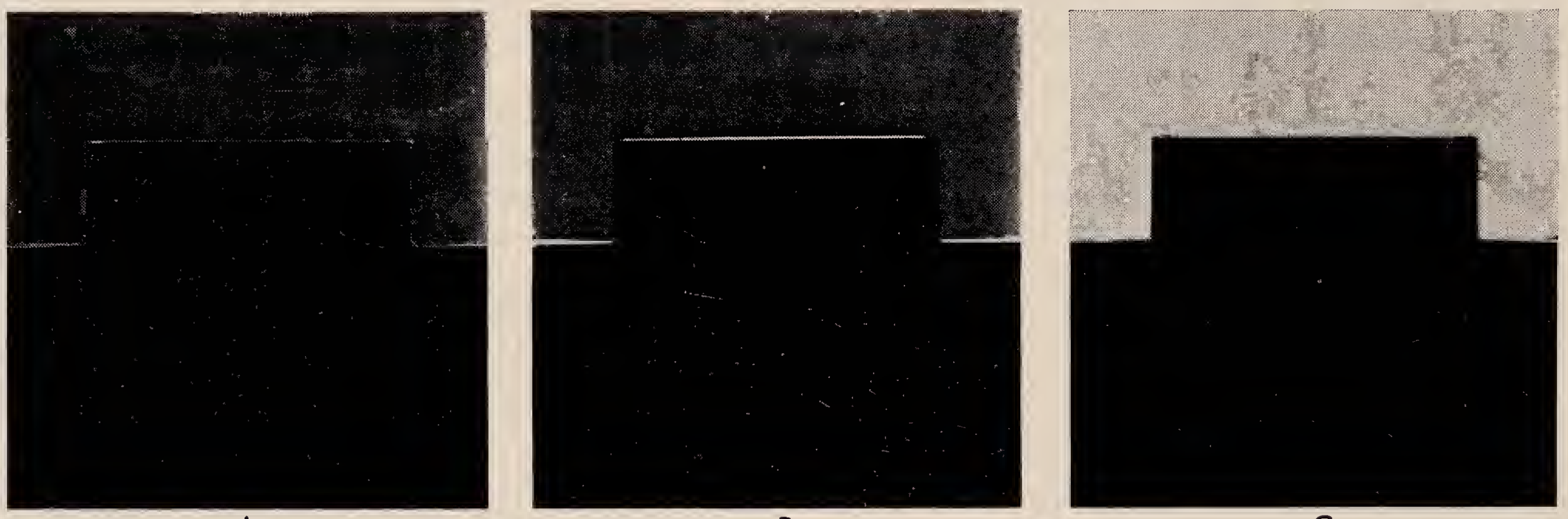
A partial prepolymer made up of isocyanate, ether glycol resin, and emulsifier. This liquid will react with water and it must, therefore, be protected from contamination by atmospheric moisture. All Component A containers should be closed when not in use in order to minimize the gellation. Care should be exercised in handling the material and to avoid it getting on the skin, and also prolonged breathing of the vapour should be avoided. The liquid Component A is a common liquid used for all foam densities in the series.

Component B

This is made up of ether glycol resin, catalyst, and water. The amount of water present determines the density of the final foam. Component B differs for each type in the series and as it tends to absorb moisture, the container should be closed when not in use, as with Component A, to prevent the absorption of atmospheric moisture. Both components may be stored at room temperature. Components A and B may be mixed either as small batches or using machine mixing. For dental application, batch mixing is the most convenient method.

As pointed out previously, the strength properties of the foam are related to the density, i.e., the degree of porosity. With standard proportions of the components, variations in density can occur if the degree of foaming before the material is placed in the mould is allowed to vary. However, using the technique described *below*, a strong rigid material can be consistently produced.

A comparison of the mechanical properties of this polyurethane foam with conventional model stone was made by casting test specimens using the technique described *below*, and carrying out compressive and bending strength tests and Rockwell hardness as described by Combe and Smith (1964) for model stones. The results (*Table I*) showed that although the polyurethane material was weaker and softer in compression, it was comparable in bending to the model stone indicating that isolated teeth on a model would be no more likely to break off than with stone. The material was also self-evidently much stronger on impact than the model stone.



A B C

Fig. 1.—Shows dimensional accuracy of A wax, B acrylic, C polyurethane models.

An estimate of the dimensional accuracy of the material in relation to acrylic resin and model stone was obtained by following the technique through in each case using a master model made from 1 in. thick black Perspex of appropriate profile to provide wax patterns. The respective models were fitted to the master and photographed against a light source to show the discrepancies of fit. *Fig.* 1 shows that a very satisfactory degree of accuracy was obtained for the polyurethane.

Table I.—PROPERTIES OF POLYURETHANE (Foam No. P.E. 406W)

	STRENGTH (P.S.I.)		ROCKWELL HARDNESS
	Compressive	*Bending*	
Model stone	9900	2500	M 105
Polyurethane foam	1750	2500	M 50

METHOD

The models which it is desired to produce in polyurethane foam are carefully trimmed and finished. Thereafter, duplicate models are produced in wax, using agar. The wax models are carefully finished, as no polishing of the final model will be carried out. Wax models are then

invested in a normal dental flask in the usual manner, the separator is applied, the second half of the flask added, and when the plaster has hardened, the wax is boiled out.

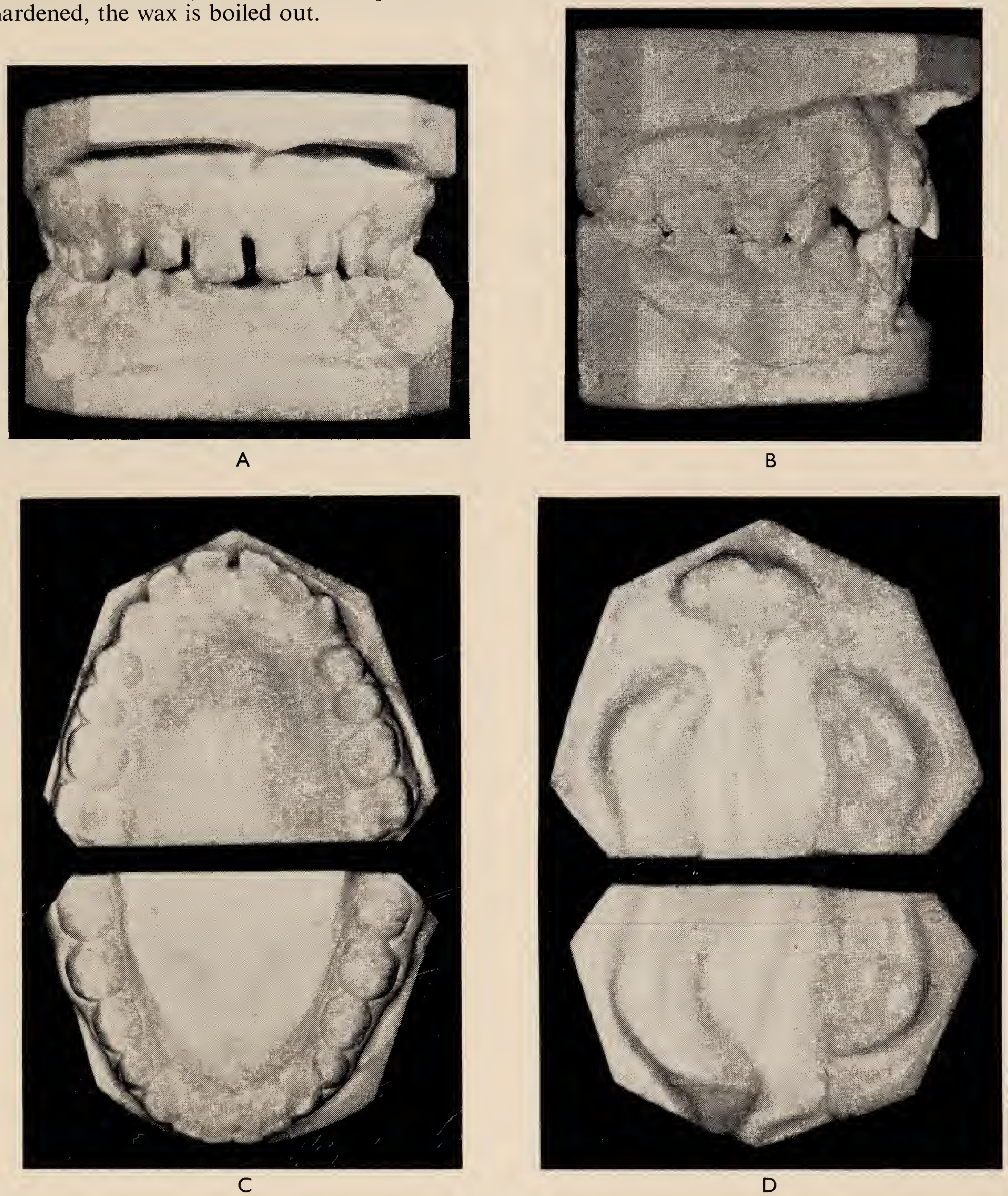


Fig. 2.—A, B, C, Routine orthodontic study models made from polyurethane foam. C, Study models of complete unilateral and bilateral cleft palate infants made from polyurethane foam.

The volume of the mould is then determined and the separating liquid is applied to the surface of the mould. It was found that clear cold mould seal gave the best result. The mould is warmed to 70° F. (21° C.).

Both components of the polyurethane system are conditioned to 70° F. (21° C.). The Components A and B are weighed out into separate mixing vessels. These vessels can be either waxed-paper cups or polythene mixing bowls. They are weighed out in the appropriate quantities to produce the proportions shown on the table for

a particular system, e.g., P.E. 406 W—mixing ratio 60 parts of Component A to 40 parts of Component B. Component A is then added to the top of the Component B and mixed. A simple mixing device which has been found to produce a satisfactory mix consists of a Black and Decker drill, stand, and paint mixing attachment. Mixing takes no more than 10 seconds and thereafter the liquid should be poured into the mould to take up two-thirds of the capacity and the lid of the flask clamped on immediately. Two models can be poured readily from any one mix.

The Spandofoam sets in 15–20 minutes, but immediately after it is foamed there is a brittle skin. This is more obvious when cold moulds have been used. The brittleness may be removed either by allowing the material to age for a few days at room temperature, or, alternatively, it has been found more convenient to heat for three hours at 70° C. in a Ditton dry curing bath. After curing the flasks are 'bench cooled'. When cool, deflasking is carried out in the standard manner. The models are washed in lukewarm soapy water to remove the remainder of the separator, and thereafter the only finishing required will be along the edge of the base of the model.

The models can be painted in different colours; if a model of one colour is desired this can be produced by using a suitable pigment. The pigment must be one which can be used in conjunction with polyester resins and dispersed in plasticizers which are unreactive towards isocyanates. The dispersed pigment should be added to the 'B' component before foaming is undertaken*. *Fig.* 2 shows examples of study models for routine orthodontic patients, and also two examples of complete clefts of the lip and palate.

SUMMARY

A technique has been described by which study models suitable for use in teaching clinics can be produced rapidly, cheaply and easily. The models produced have also considerable potential as long-term records for use in cases where the patient will be kept under review for a good number of years, for example, patients who have had pre-operative orthodontic treatment for cleft lip and palate conditions, and will be under observation until growth has ceased.

Acknowledgements

I wish to acknowledge with gratitude the help received from colleagues in the preparation of this paper, in particular from Dr. Robert Ollerenshaw, of the Department of Medical Illustration, and Dr. Dennis Smith, of the Department of Prosthetics.

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*Pigment Dispersions are obtainable from: Reeves & Sons Ltd., Lincoln Road, Enfield, Middlesex.

REFERENCES

Combe, E. C., and Smith, D. C. (1964), *Brit. dent. J.*, **117**, 237.

Morrant, G. A. (1953), *Ibid.*, **95**, 103.

White, T. C., Gardiner, J. H., and Leighton, B. C. (1957), *Orthodontics for Dental Students*, p. 148, London: Staples.

AN EVALUATION OF FIVE METHODS OF DEROTATING UPPER MOLAR TEETH

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THE purpose of this paper is to describe the method of construction of five appliances used for derotating maxillary molar teeth and to discuss the clinical value of each appliance. These five techniques will be numbered according to their clinical usefulness, and indications will be given for the use of each method. All of these techniques have been described separately on previous occasions, but it was thought that a discussion of the advantages and shortcomings of each technique would help the clinician in selecting the method most appropriate to a particular clinical problem.

It should be pointed out that the word ‘ de-rotation ’ is introduced since it is thought that it more accurately describes the process of treatment to aline a tooth that is rotated.

INDICATIONS FOR DEROTATION

Almost all degrees of rotation of molars relative to the arch form may be seen. A study of adult malocclusion shows that many of these variants are compatible with dental health. The decision to derotate an upper molar stems from the need to create space for alinement and to intercept a potentially traumatic cuspal relationship. Additional benefits are a lowered risk of pulpal involvement from interstitial caries in the molar and an improved dento-gingival contour.

Some orthodontists consider that rotated molars cannot be moved distally until they have been alined. The author has not found this to be correct and the problem in moving rotated molars distally is technical, rather than physiological.

WHEN IS A MOLAR ALINED?

Each individual may only possess an occlusion which is the optimal one relative to his or her underlying skeletal and soft-tissue morphology. Therefore to speak of a ‘ normal occlusion ’ or a ‘ normal rotational relationship of a molar relative to the dental arch ’ is to speak of an abstraction. Every treatment, however, must have an aim, and the following guide to the attainment of an optimal improvement is suggested. This occlusal tracing shows what could be considered to be an ideal occlusion (*Fig.* 1). It reveals upper first permanent molars which at first sight appear to have a slight mesio-buccal rotation. A comparison with other

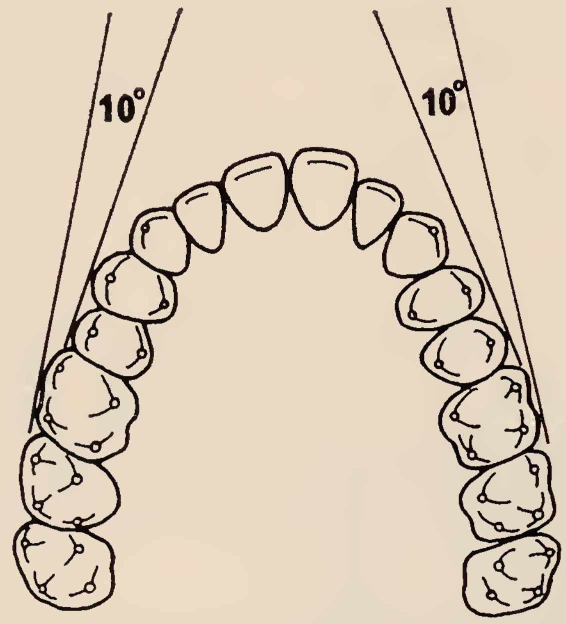


Fig. 1.—On an occlusal tracing of an ideal occlusion, a tangent to the buccal surface of the first permanent molar does not follow the general curve of the arch, but forms an angle of approximately 10° to a line connecting the buccal surfaces of the premolars. This is the suggested optimal position or treatment aim during upper molar derotation.

occlusal photographs of ‘ normal ’ occlusions (Graber, 1961; Massler and Schour, 1948) shows a similar picture. A tangent to the buccal surface of the first permanent molar does not follow the general curve of the arch, but forms an angle of approximately ten degrees to a line connecting the buccal surface of the premolars. In this position the upper first molars present their smallest diameter to the arch form and therefore take up *least space*. This can be shown by tracing the upper first molars and rotating the tracing paper to assess the additional space required with any other rotational relationship. The broadening of the width of interdental contact improves the functional protection of the interdental papilla.

Too often, rotated molars are undertreated with a failure to achieve an optimal improvement.

Demonstration presented at the Country Meeting held in Birmingham on 1 May, 1965.

THE FIVE METHODS

Removable appliances are of no value in the rotation of upper molars. Cemented bands must be used. Buccal working archwires by themselves, either round or edgewise, cannot be effectively used for the rotation of upper molars, since the reaction on the premolar mesial to the molar will cause the premolar to move into a cross-bite. Method 3 (*see below*), Reciprocal Rotation with Palatal Elastics, helps overcome this problem.

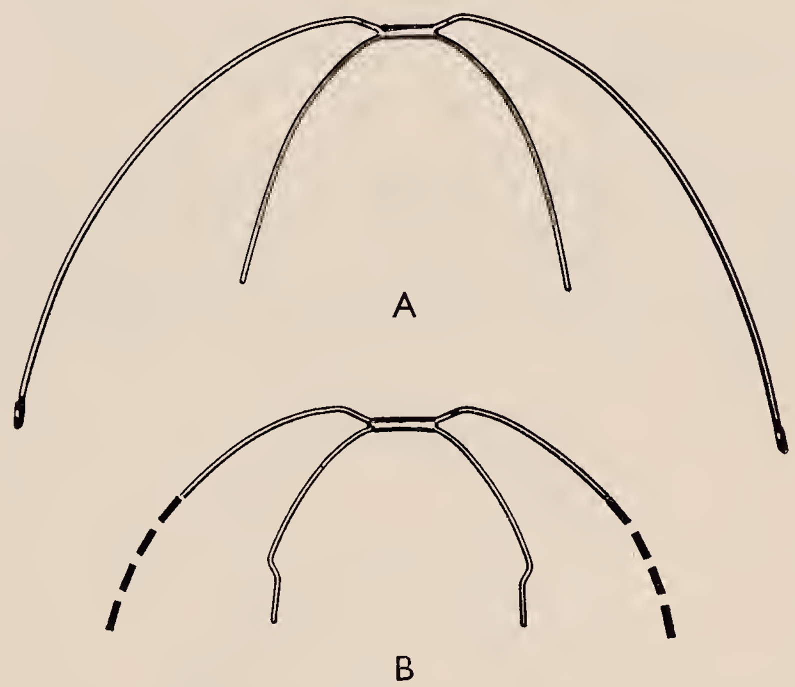


Fig. 2.—A pre-formed arch which can be made in the laboratory. It can be rapidly adapted in the mouth to the arch form and necessary arch length. A, Preformed E.O.T. arch 1·5-mm. external arch and 1·25-mm. internal arch. B, Inner arch with ' Z ' stops. The most mesial bend is progressively increased to derotate the molar.

Methods 1, 2, 4, and 5 are variants of the labio-lingual technique. Method 5, the Smyth Rotator, uses the heavy 1-mm. wire as a framework and rotates the molar with a light spring. By contrast, in Methods 1 and 2, the heavy arch itself is activated. Remembering that the methods are numbered in a descending order of clinical usefulness, this may seem a negation of modern views on the movement of teeth by light spring pressures. The only justification is that Methods 1 and 2 work, and work well, without apparent undesirable side effects.

Method 1

Progressive Angulation of the Distal Ends of a Stopped Arch for Extra-oral Traction

INDICATIONS FOR USE

This method is indicated for slight to moderate rotations where some distal movement of the upper molar is required. It is the method of choice if the molar to be rotated can be approached from the buccal. Treatment can be started at the first visit if prefabricated arches are available (*Fig.* 2). They are made of a 1·5-mm. stainless-steel wire external arch or ' whisker ' and a 1·25-mm. inner arch. These extra-oral traction arches are pre-formed in the laboratory to a standard pattern (*Fig.* 2 A). The pre-formed arches can be readily adapted to suit most cases and save time and operator fatigue. This heavy arch is preferred by the author since it gives a more positive control of the mesiodistal tipping of the molar. This is a personal choice since the inner arch can be 1·00, 1·14, or 1·25-mm. wire. A 1·14-mm., or more exactly 0·045-in., wire has recently become available, and is a compromise between flexibility and control for the inner arch.

The molars to be derotated are banded and tubes soldered to the buccal of the bands. If the rotation is mild, or a premolar is to be extracted, the tubing can be soldered parallel to the buccal surface. The tubing must be offset, as in *Fig.* 3 A, if the mesiobuccal corner of the upper molar is so palatally placed that deformation of the arch will not allow the ends of the inner arch to be inserted into the tubing.

When the bands have been cemented, the inner arch of the preformed extra-oral traction arch is inserted in the mouth and the arch length marked, allowing 2–3 mm. clearance between the inner arch and the labial of the upper incisors. This mark is then gripped with a pair of Universal pliers and a crank or bayonet bend is bent into the inner arch (*Fig.* 2 B). This bend is both a stop and the point from which the arch is activated. ' U ' loops are difficult to bend in 1·25-mm. wire and fracture more readily with repeated activation than the Z-shaped stop.

At the first visit the arch must be passive to allow the child to become used to inserting the arch. On subsequent visits, the distal end of the arch is progressively angulated to derotate the molar. An exaggerated amount of angulation is shown in *Fig.* 3 C for display purposes. A suitable amount of activation for the mouth using a 1·25-mm. inner arch is shown in the photograph inset in *Fig.* 3. If the arch is over-activated it is too difficult to insert. A gentle but firm compression of the activated inner arch in the canine region will slide it into the tubes (*Fig.* 3 E). It is important that the inner arch is *expanded* slightly each visit to prevent the rotated molar from moving palatally as it derotates.

With unilateral molar derotation a reciprocal undesirable rotatory effect on the opposite molar has not been observed. With bilateral cases, each molar should be activated on alternate visits.

ADVANTAGES

1. The apparatus is simple to make and requires relatively little chairside time.

2. It does not add to the total time of treatment since the derotation takes place simultaneously with distal movement of the molars. If

distal movement of the derotating molar is not critical, an upper removable appliance can be worn while derotation is taking place.

3. The rotated molar can be precisely positioned in the suggested optimal position.

Disadvantages

In a small percentage of cases, the buccal tubes need realinement after the molar has been rotated.

placed just to the mesial of the middle of the palatal surface (*Fig.* 4 A, 6|). Whilst placing the box further to the distal will theoretically increase the buccal movement during rotation, in practice it makes the palatal arch difficult to activate. A 1-mm. stainless-steel palatal arch is then bent to contact all the maxillary teeth with the exception of the canine and first premolar on the opposite side to the rotated molar. It is kept 1-mm. away from these teeth (*Fig.* 4 A, |34) to

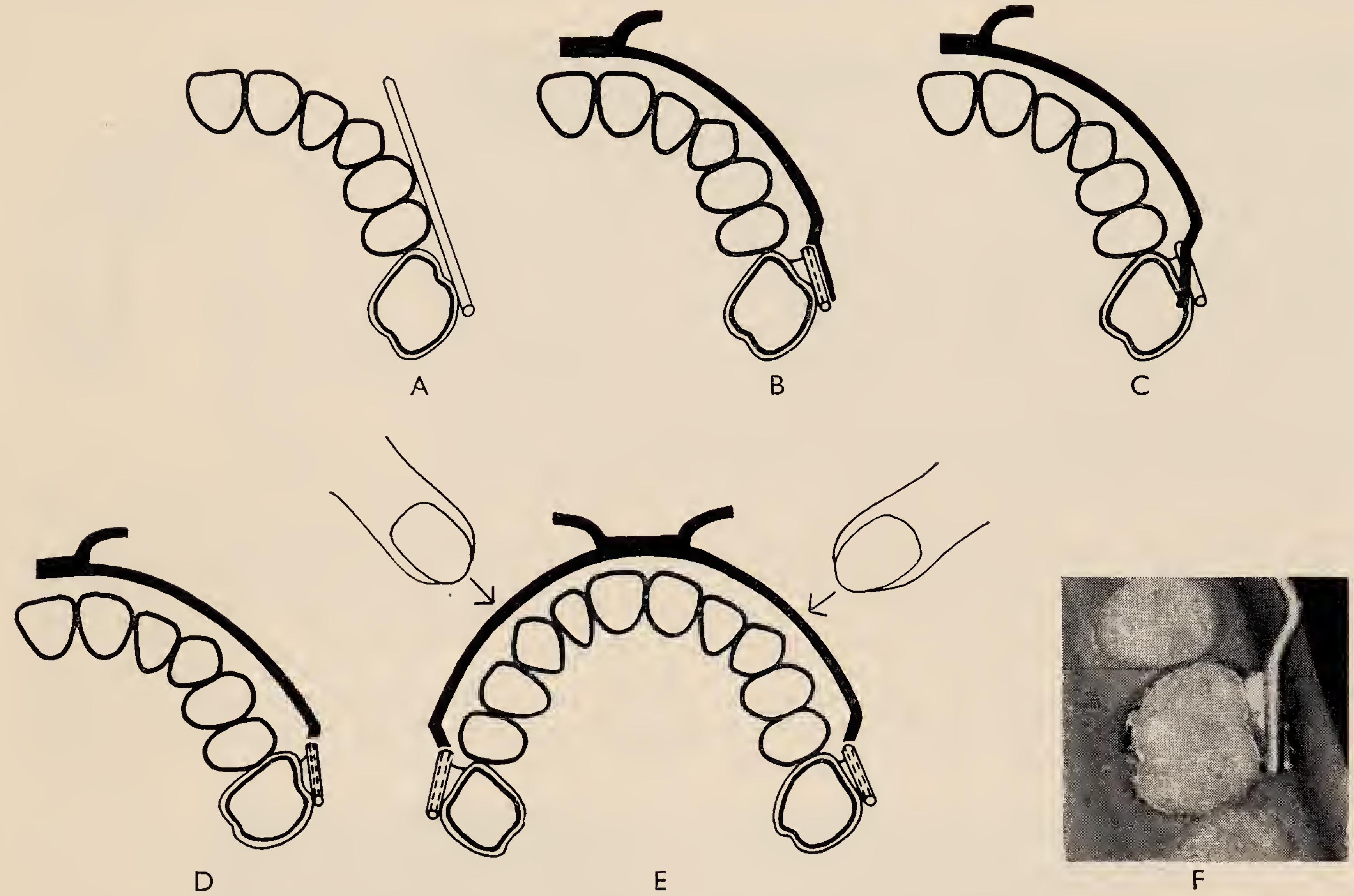


Fig. 3.—Progressive angulation of the distal ends of a stopped arch for extra-oral traction. Method 1. A, The molar to be derotated is banded. The buccal tubes are soldered parallel to the buccal surface, or offset if necessary (*see text*). B, The arch should be passive on the first visit to allow the patient to become accustomed to wearing the apparatus. C, The distal end of the inner arch is progressively angled, so that, when inserted in the tube, it will derotate the molar mesiobuccally. (Exaggerated for diagrammatic purposes.) D, If initially the tubing was offset it may need realining when the molar derotation is completed. This is necessary in relatively few cases. E, It is important not to over-activate the arch or it will be too difficult to inset. A gentle, but firm, compression in the canine region will slide the correctly activated arch into the tubes. F, A suitable amount of activation of a 1·25-mm. arch for use in the mouth. The molar is derotated a small amount at each visit.

Method 2

Progressive Angulation of the McKeag Post on a Palatal Arch

Indications for Use

This method is indicated for all upper molar rotations which cannot be approached from the buccal. This group includes all severely rotated molars as well as moderate rotations where the molar is palatally placed, having one or both buccal cusps in cross-bite (*Fig.* 4).

Molar bands are made and McKeag boxes added. On the rotated molar the box should be reduce the theoretical possibility of buccal thrust when the arch is activated (*Fig.* 4 C, D). McKeag posts and 0·6-mm. soft stainless-steel locks are added to the palatal arch.

Activation of the palatal arch

The wire running through the McKeag post of the *molar to be derotated* is gripped across the post with a pair of pliers (*Fig.* 4 B) so that the bend to activate the arch can be made as close to the McKeag post as possible. It is important that the pliers are angulated so that the occlusal plane of the palatal arch is held horizontal

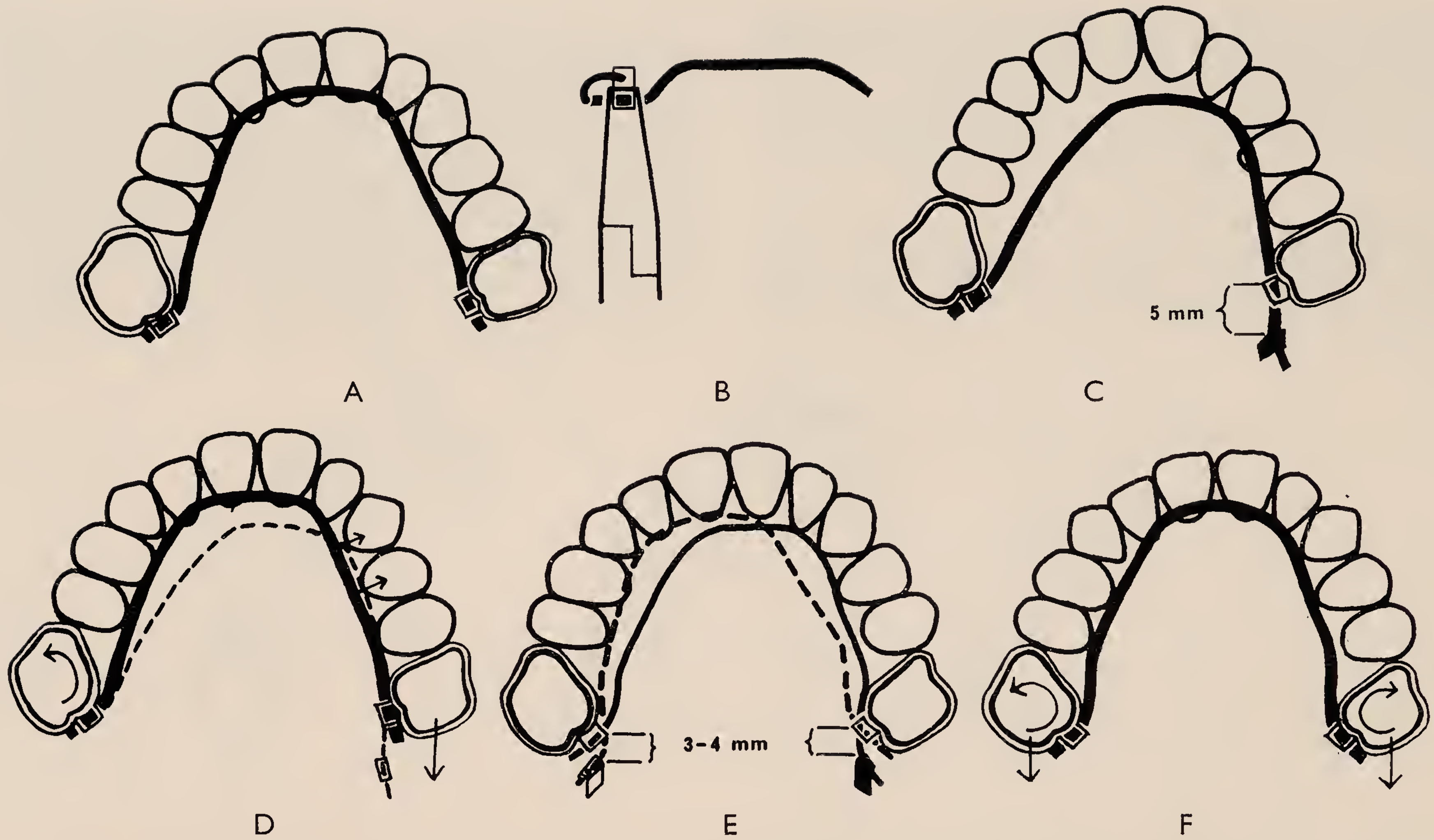
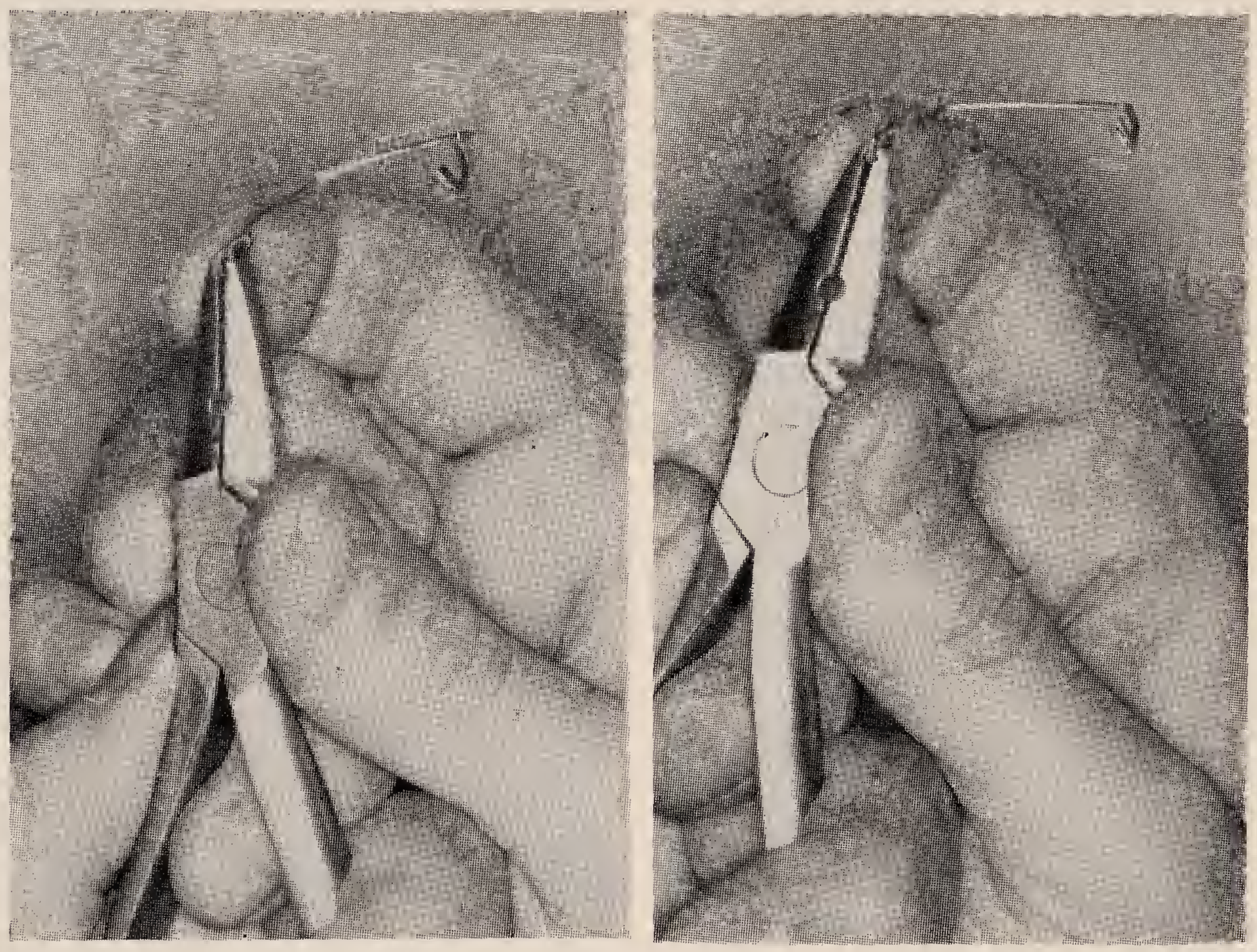


Fig. 4.—Progressive angulation of a McKeag post on a palatal arch. Method 2. A, When a molar is to be derotated, e.g., 6| the McKeag box is placed on the mesial half of the palatal surface of the band. The 1-mm. palatal arch contacts all teeth except the premolar and canine opposite the molar to be derotated. B, Flat pliers are used to grip the arch across the McKeag post of the molar to be derotated. The bend to activate the arch is then made just mesial to the post. C, To test that the arch is correctly activated the McKeag post is inserted in 6| only. The non-inserted post, |6, should lie 5 mm. distal to its box. D, When both McKeag posts are placed in their boxes there is a mesiobuccal rotating force on 6|, a distal force on |6 and possibly light palatal pressure on |34. E, When activated bilaterally less activation should be used. When testing the activation the posts are inserted one at a time in their respective boxes. Each non-inserted post should be 3–4 mm. distal to its box. F, When activated bilaterally the palatal arch will rotate both molars mesiobuccally. The distal force prevents any mesial movement during derotation.

A



B

Fig. 5.—A, *Incorrect*: The occlusal plane of the palatal arch is not horizontal. B, *Correct*: The flat pliers are held at the angle required to keep the occlusal plane horizontal. The arch is being activated to rotate 6|. The index finger of the right hand is bending the palatal arch towards the reader.

during activation to avoid tipping the occlusal plane of the arch and producing buccopalatal root torque on the molars (*Fig.* 5). With the arch gripped as in *Fig.* 5 B, the portion of the arch just mesial to the pliers is bent palatally. This activates the arch. When the McKeag post of the molar to be derotated is replaced in its box, in the mouth (*Fig.* 4 C, 6|), the non-inserted McKeag post of the opposite molar, |6, should be 5 mm. distal to its box. When both McKeag

A B C D

Fig. 6.—Reciprocal rotation with palatal elastics. Method 3. A, A diagram showing the position of the palatal hooks and the elastic which would be used to derotate |4 distobucally and |6 mesiobuccally. B, C, and D. In order to create space for the vertically impacted 3|, 64| were derotated using palatal elastics and Method 1.

posts are inserted in their boxes (*Fig.* 4 D), there will be a derotatory force on 6|, and a distal force on |6.

If bilateral molar derotation is needed, treatment should be started on the more severely rotated molar first. When the tooth has been partially derotated, the arch can be activated bilaterally (*Fig.* 4 E). Less activation, e.g., 3–4 mm., should be used to avoid excessive forces. When the arch is inserted, both molars will be rotated (*Fig.* 4 F). While the theoretical distal force on both molars is insufficient to cause actual distal movement, it will completely prevent any mesial movement of the molars during their derotation. Where a cross-bite exists, expansion of the palatal arch is necessary. This method may be used in the lower arch.

Advantages

All degrees of molar derotation can be treated by this method, which by virtue of its simplicity and efficacy has largely replaced the Smyth Rotator (Method 5). It is sturdier, works more rapidly on average, and is less complicated to make.

Disadvantages

Until the clinician is familiar with the appliance, care must be taken in activating the palatal arch.

This appliance has been numbered second in descending order of clinical usefulness only because severe rotations of upper molars are less common than mild rotations. It is often useful to combine Methods 1 and 2. Severely rotated molars can be banded and have a McKeag box placed on the palatal and 1·25-mm. tubes added to the buccal aspect of the band. The teeth are then partially derotated with a palatal arch (Method 2) until the derotation and distal movement of the molars can be continued from the buccal with a stopped arch for extra-oral traction (Method 1).

Method 3

Reciprocal Rotation with Palatal Elastics

This method is not intended to be used by itself but in combination with either a multiband technique or Method 1.

Indications for Use

In the same quadrant as the mesiopalatally rotated molar there must be a distopalatally rotated premolar or canine. In this situation, by using a palatal elastic, the reaction to the mesiobuccal rotation of the molar can be used to derotate a premolar distobuccally. Alternatively, the reaction can be used to rotate slightly, but principally retract a distopalatally rotated upper canine.

Absence of 5|5 from the arch may result in mesiopalatal rotation of 6|6 and distopalatal rotation of 4|4. In this case, e.g., *Fig.* 6 A, |46 would be banded and palatal hooks of 0·6-mm. soft stainless-steel wire would be tack-welded and soldered to the bands; |4 hook pointing mesially and |6 hook pointing distally. The palatal hook on the molar should be placed on the mesial of the palatal surface since it functions

adequately in this position, and, if placed too far to the distal, it can cause tipping of the molar. To the buccal of the molar band, either a sheath for multiband or a tube for extra-oral traction is attached.

When the bands have been cemented, a suitable elastic is chosen to stretch from one palatal hook to the other. A rough guide to the size of elastic is that its passive length should be half of the span between the hooks. This elastic will then rotate the molar mesiobuccally and the premolar distobuccally.

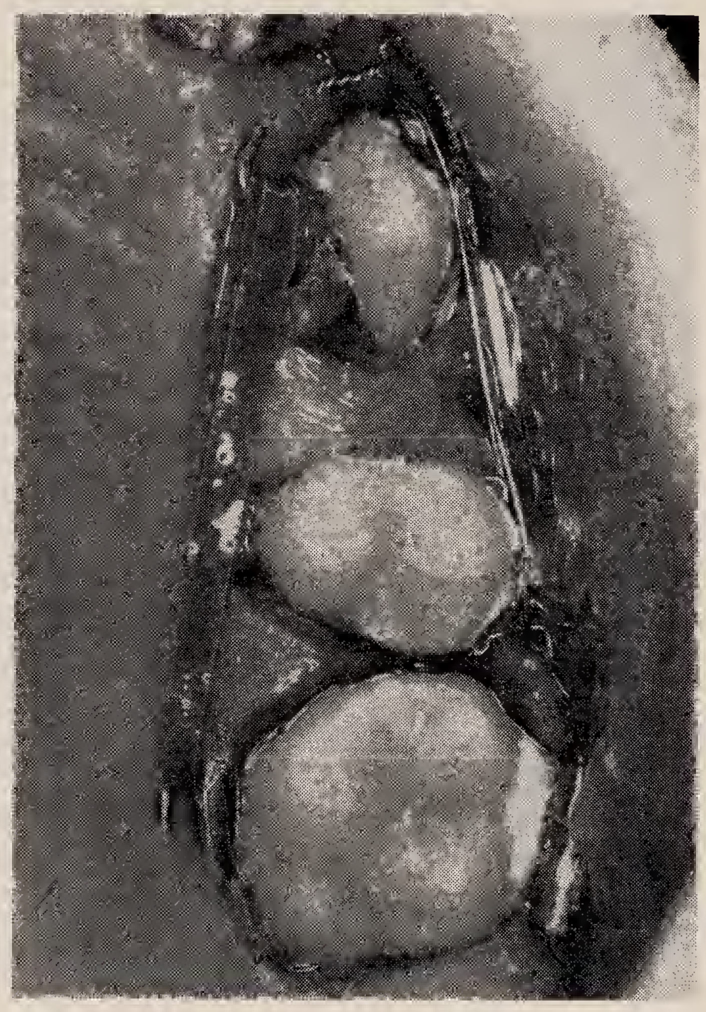


Fig. 7.—An intra-oral photograph showing a buccal push coil on a light round wire and a palatal elastic, which are used in combination to retract the upper canine, and also to produce slight reciprocal rotation of the canine mesiopalatally, and the first permanent molar mesiobuccally.

Fig. 6 B, C, and D shows a combination of this technique and Method 1 used to derotate $\underline{64|}$ in order to create space for $\underline{3|}$ which was vertically impacted in the alveolus.

It has been previously stated that the use of buccal working arch wires, either light round wire or edgewise wire, for derotating molars is contra-indicated. If working arches are used in this way, the reaction may cause the premolar mesial to the molar to move palatally into cross-bite. The combination of palatal elastics with a multiband technique uses the reaction to the derotation of the molar to aline the premolar.

If a multiband technique is used to retract upper canines, this may consist of a compressed coil on the buccal working arch wire which pushes against the mesial of the canine bracket. This buccal compressed coil can sometimes cause unwanted mesiobuccal rotation of the canine. Alternatively, it may worsen an existing mesiobuccal rotation of the canine and a mesiopalatal rotation of the first permanent molar.

When the teeth are being banded, this problem should be anticipated and palatal hooks added to the canine and first permanent molar bands (*Fig.* 7). The palatal elastic will then reciprocally rotate the canine mesiopalatally, and the molar mesiobuccally, besides aiding in the retraction of the canine.

In most cases, an upper removable appliance is the appliance of choice to retract upper canines. When, however, multiband therapy is indicated, the palatal elastic provides a useful counter to the undesired tooth movements produced by a purely buccal approach and a means of derotating the canine and first permanent molar whilst canine retraction is taking place. In addition, the canine retraction can be rapid with minimal tilting. These palatal hooks and elastics are well tolerated.

Advantages

Treatment from the palatal aspect utilizes the reciprocal forces to aline and derotate other teeth.

Disadvantages

1. Forethought is required during banding, concerning the placing of the palatal hooks.
2. It is a sophisticated technique, requires a good patient and usually extra-oral traction.

Method 4

A Terminal Hinged Section on a Stopped Arch for Extra-oral Traction

Indications for Use

These are the same as for Method 1, i.e., slight to moderate rotations where some distal movement of the upper molar is required.

This technique was fully described by Brenchley (1964). An arch for extra-oral traction with ‘ U ’ loops was modified so that the portion of the inner arch that was inserted into one of the molar tubes was free to rotate through an arc of approximately 45°. Brenchley considered that the palatal root offered resistance to mesial migration and acted as a rotational axis about which the tooth rotated as it drifted mesially following loss of mesial contact. The terminal hinged section allows the molar to rotate freely as it is moved distally and is used in an attempt to reverse the process that produced the rotated molar.

Advantages

If the rationale of this method is correct, then it is a more physiological approach to the

derotation of the molars that are being moved distally.

Disadvantages

It is a slightly more complicated way of achieving the same end result as Method 1.

Since Method 1, the progressive angulation of the distal ends of a stopped arch for extra-oral

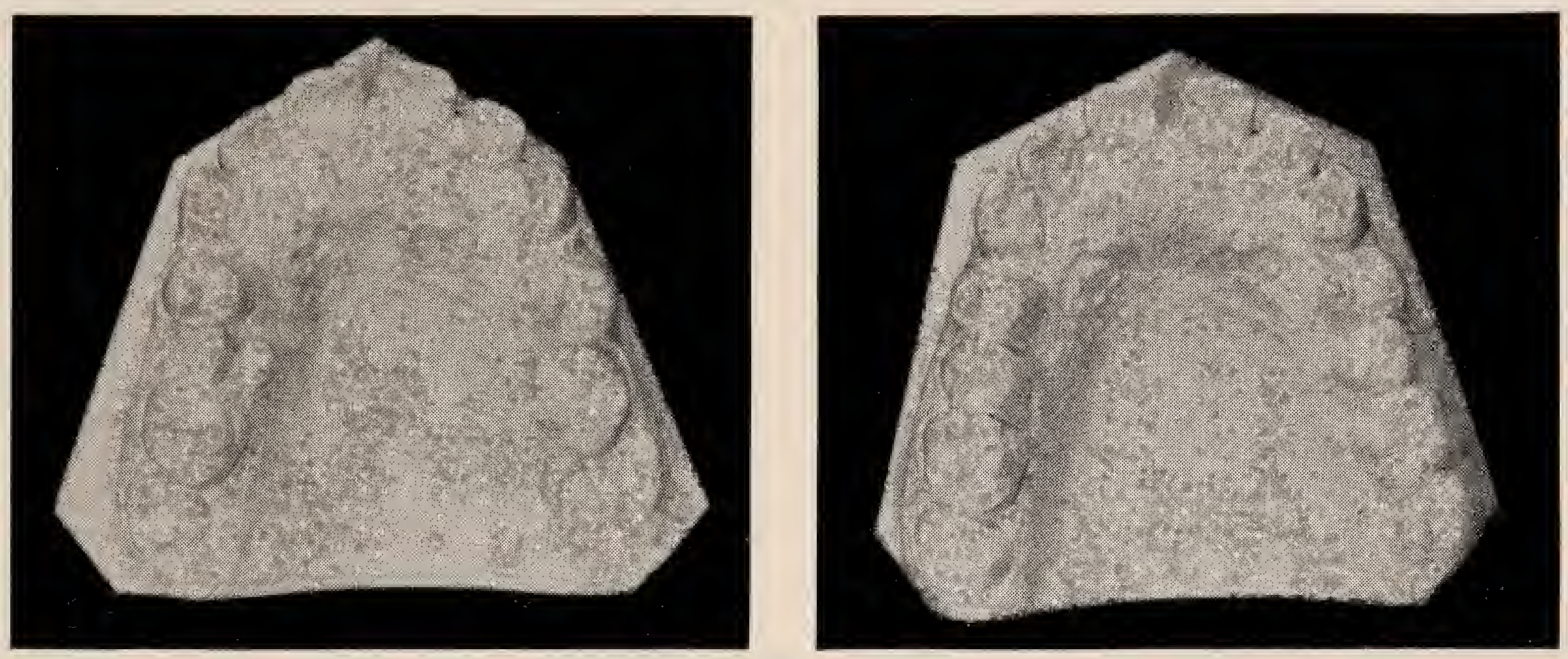


Fig. 8.—These occlusal photographs show one of the two types of case for which the Smyth rotator is still indicated. By placing lateral arms distal to 4|4 the mesial movement of the palatal arch has been used to close spacing anterior to 4|4 to open space for the impacted 5|5.

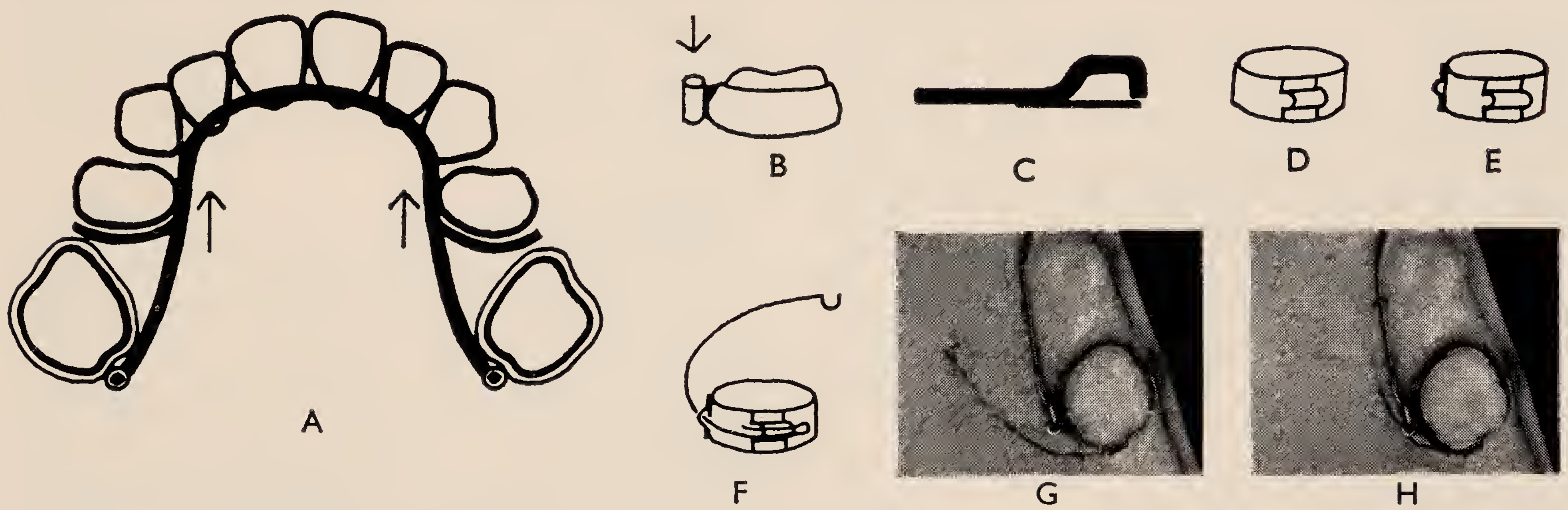


Fig. 9.—Smyth rotator. Method 5. A, A 1-mm. palatal arch is bent in contact with all the teeth. The ends are turned vertically to enter the 1-mm. tubing. Lateral stops in 0·6-mm. hard stainless-steel are sometimes soldered distal to 4|4 (*see text*). B, The 1-mm. tubing should be vertical and not follow the slope of the palatal surface. C, 0·6-mm. soft stainless-steel locks are soldered to the arch. D, A buccal sheath of 0·2 × 2·5-mm. soft tape is welded to the band. E, A distal sheath 0·1 × 2·5-mm. tape guards the spring. F, The spring, 0·4 or 0·45-mm. hard stainless-steel wire is folded back on itself and drawn through the sheaths until it locks in the buccal sheath. A hook to latch onto the arch is then bent into the spring. G, Passive position of the spring. H, Active position with the spring tucked beneath the arch.

traction, produces good clinical results without patient discomfort or apparent damage to the molar or its supporting tissues, it is preferred as a technique.

Method 5

The Smyth Rotator

This appliance has been used for many years in this country for derotating upper molars (Smyth, 1930; Friel and McKeag, 1939). It may be used to treat any degree of molar rotation, sometimes most effectively (*Fig.* 8). But clinical usage has shown the Smyth rotator to have a number of undesirable characteristics. It is an appliance that breaks frequently and repairs may be very time consuming. It is a complicated appliance to make. Since no other tooth movements can be started until the molar derotation is finished, it may add up to six months to the duration of treatment.

Indications for Use

The reaction to the activation of the springs is translated into a mesial component of force on the palatal arch (*Fig.* 9 A).

The indication for the use of the Smyth rotator lies in the utilization of this reaction to treat other features of the malocclusion besides the molar rotation.

It may aid in the correction of a Class III incisal relationship or assist in the disimpaction of second premolars. In this second type of case there must be spacing mesial to the first premolar so that the lateral arms distal to 4|4 (*Fig.* 9 A) move the premolars mesially to open 5|5 spaces (*Fig.* 8).

Technique of Construction

Upper molar bands are made and a working model obtained. A vertical 1-mm. tube is soldered to the palatal surface of the band. This tubing should be at right-angles to the horizontal plane and *not* follow the slope of the palatal surface of the upper molar (*Fig.* 9 B). This makes the palatal arch easier to bend and permits expansion of the palatal arch without buccal tipping of the molars. The further distal the tube is placed the greater the permitted amount of buccal and distal movement of the derotating molar. A 1-mm. palatal arch is bent in contact with all teeth with the ends of the arch bent vertically to enter the tubes occlusally (*Fig.* 9 A), 0·6-mm. soft stainless-steel wire is added as a lock to retain the arch (*Fig.* 9 C). On the buccal aspect of the molar band a horizontal sheath of soft tape is welded, e.g., 0·2 × 2·5 mm. (*Fig.* 9 D). A smaller sheath, e.g., 0·1 × 2·5 mm., is welded to the distal of the band to act as a guide for the spring (*Fig.* 9 E). This is difficult if 6|6 are being derotated and 7|7 have erupted. A 0·4 or 0·45-mm. spring is added as in *Fig.* 9 F. This technique of attaching the spring lengthens it and avoids direct soldering with the risk of annealing the spring. The photographs (*Figs.* 9 G and H) show the passive and active position of the spring. When the spring is hooked onto the arch, it should be tucked under the arch as much as possible to protect the spring from damage.

Advantages

The reaction to the derotation of the upper molars can be used to correct a Class III incisal relationship or to close spacing anterior to the upper first premolars.

Disadvantages

1. The appliance breaks much more frequently than other types of labiolingual apparatus.
2. Repairs may be time consuming.
3. It is a complicated appliance to make.
4. No other treatment can take place until the appliance has completed the molar derotation.
5. Progress is slow in many cases.

Method 2, the progressive angulation of a McKeag post on a palatal arch, avoids most of these disadvantages.

SUMMARY

A short survey of the reasons for derotating upper molars has been presented together with a suggested optimal improvement which may be sought in each case. Five methods of derotating upper molars, numbered according to their clinical usefulness, have been described in detail. The indications of the sphere of usefulness of each technique as determined by its advantages and disadvantages have been given. The following might be said by way of summary:—

If the rotation is slight to moderate, and distal movement of the molar is required, then, so long as this movement can be approached from the *buccal* Method 1 (progressive angulation of the distal ends of a stopped arch for extra-oral traction) should be used. In the case of all severe rotations, as well as moderate rotations with palatal placement of the molar, the approach should be from the *palatal* by means of Method 2 (the progressive angulation of the McKeag post on a palatal arch). Methods 1 and 2 are in fact equally valuable and may usefully be combined (*see above*). Method 3, reciprocal rotation with palatal elastics, is an accessory technique for use in certain specified cases. The reasons for restricting the use of the Smyth rotator, Method 5, have been given.

Acknowledgements

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REFERENCES

Brenchley, M. L. (1964), *Dent. Practit.*, **15,** 157.

Friel, S., and McKeag, H. T. A. (1939), *Dent. Rec.*, **59,** 359.

Graber, T. M. (1961), *Orthodontics, Principles and Practice.* Philadelphia: W. B. Saunders Co.

Massler, M., and Schour, J. (1948), *Atlas of the Mouth.* Chicago: American Dental Association.

Smyth, K. C. (1930), *Dent. Rec.*, **50,** 307.

SOME SPONTANEOUS AND ADVANTAGEOUS TOOTH MOVEMENTS

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NATURAL tooth movements can be helpful to orthodontists, and some of these, other than the common mesial ones, are considered here.

1. DISTAL APICAL MOVEMENT

Distal apical movement can occur subsequent to the retraction of:—

a. Upper Premolars

During orthodontic treatment, upper premolars may be retracted into the space created by the extraction of the first permanent molars. Often, on retraction, they are found to tilt distally about a point well coronal to their apices, in spite of the use of light forces. Clinical experience suggests that these premolars may upright later. In addition to any mesial movement of the crowns that may occur (e.g., during occlusal settling after treatment or as the result of growth), it would appear that an actual distal apical movement may contribute to this uprighting where the premolar crowns are held by the adjacent teeth and the occlusion. (*See Fig.* 1—full records of this case were shown.) This is more likely to occur when the distal tipping during retraction is excessive, and, less likely, when the antrum extends downwards between the roots of the upper second molar and second premolar.

b. Upper Canines

Less commonly, a similar phenomenon can occur following the retraction of upper canines. (*See Fig.* 2—full records of this case were shown.)

c. Upper Incisors

If upper incisors are retracted to within lower lip activity by tilting them palatally with marked labial apical movement (often the result of excessive forces), they may tend to upright later with some palatal apical movement. (*See Fig.* 3—full records of this case were shown.)

Fig. 1.—Tracings of lateral skull radiographs of Patient K.B., superimposed on ANS and the maxillary plane, showing changes in upper premolars. A, During treatment. B, Following treatment. C, Overall.

It would seem a reasonable contention that an upright tooth is best able to withstand occlusal forces, and that these forces may result in spontaneous tooth movement to achieve this inclination. This most commonly occurs by mesial movement of the crown of the tooth. But where this is prevented by the continuity of the dental arch, or by the lower lip, distal apical movement

A Demonstration presented at the Country Meeting held in Birmingham on 1 May, 1965.

may occur. The fact that this movement is a partial relapse (*Figs.* 1, 2, and 3) may also be of some significance with regard to its occurrence.

The above contention relating to functional forces reinforced by certain clinical observations led to the following two interrelated questions being posed. Is it a coincidence that those lower second premolars that tilt mesially to an excessive degree, following the extraction of lower first premolars, are usually out of occlusion? Also, that lower second premolars that are in occlusion before the extraction of the lower first premolars are, later, less likely to tilt excessively on drifting mesially than those that are unerupted at that time? Another possible aetiological factor here is the occurrence of a period of rapid mesial drift coinciding with the eruption of the lower second molar before the second premolar has erupted into occlusion.

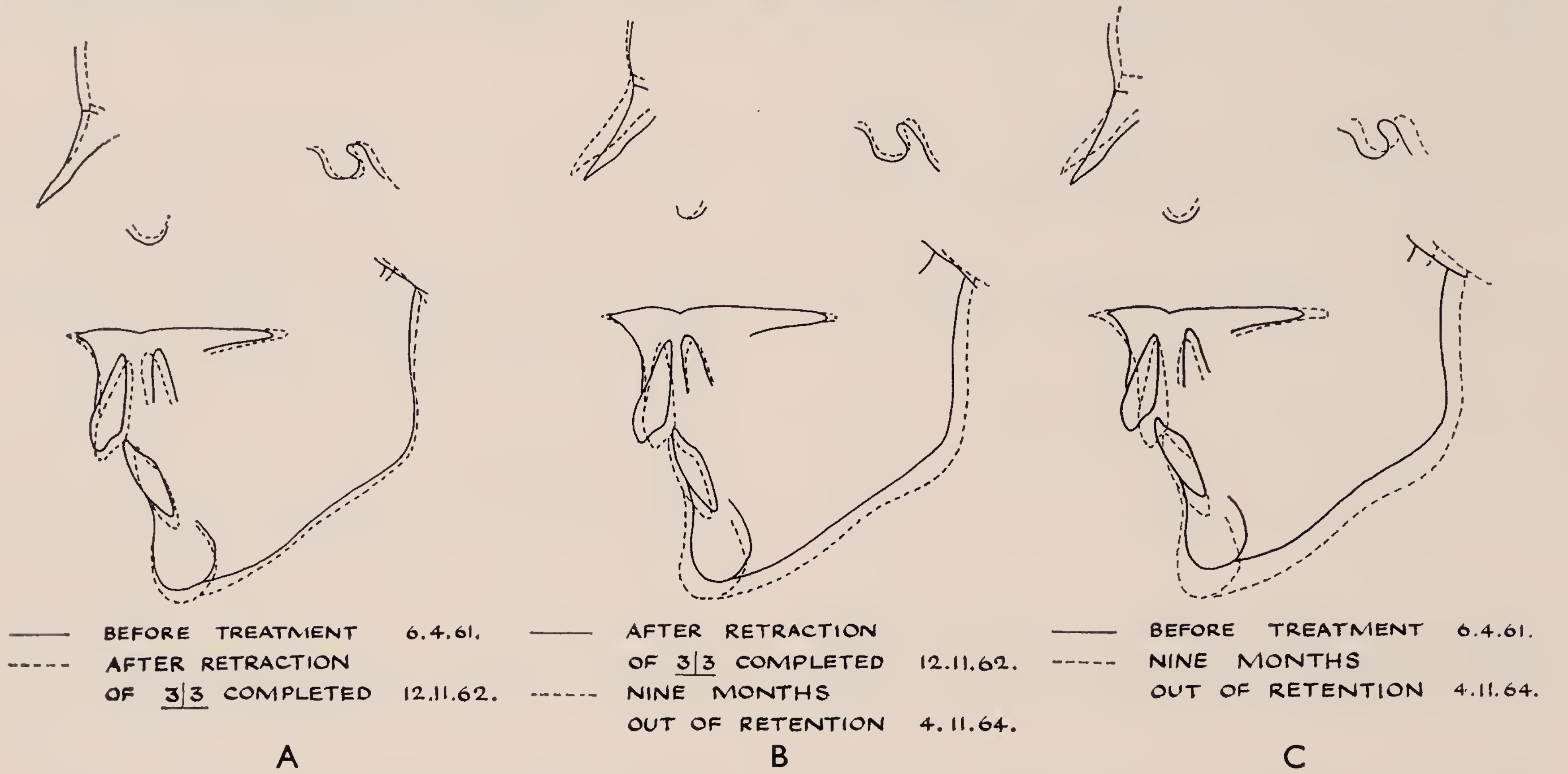


Fig. 2.—Tracings of lateral skull radiographs of Patient I.L., superimposed on ANS and maxillary plane, showing changes in upper canines. A, During treatment. B, Immediately following treatment. C, Overall.

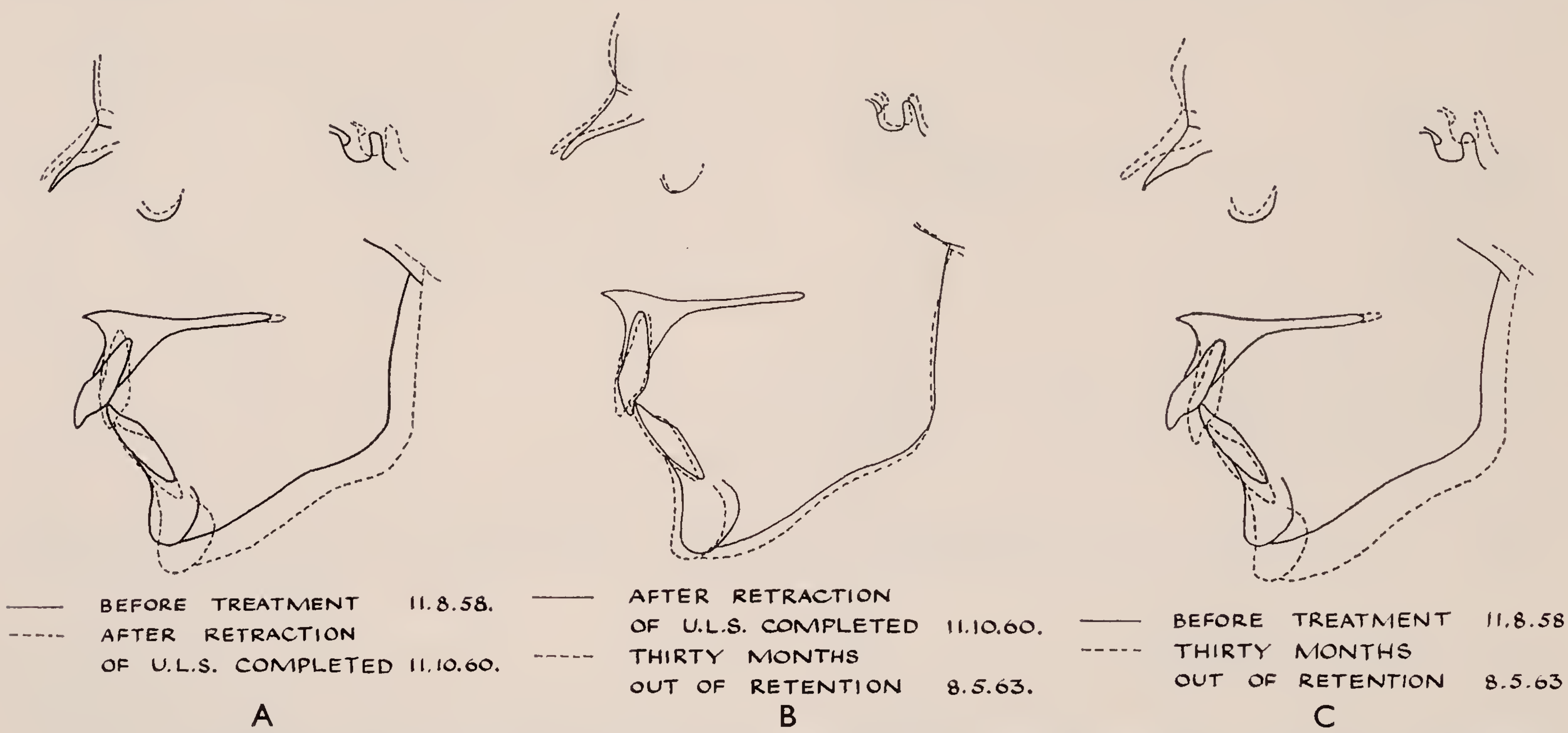


Fig. 3.—Tracings of lateral skull radiographs of Patient D.G., superimposed on ANS and maxillary plane, showing changes in upper incisors. A, During treatment. B, Immediately following treatment. C, Overall.

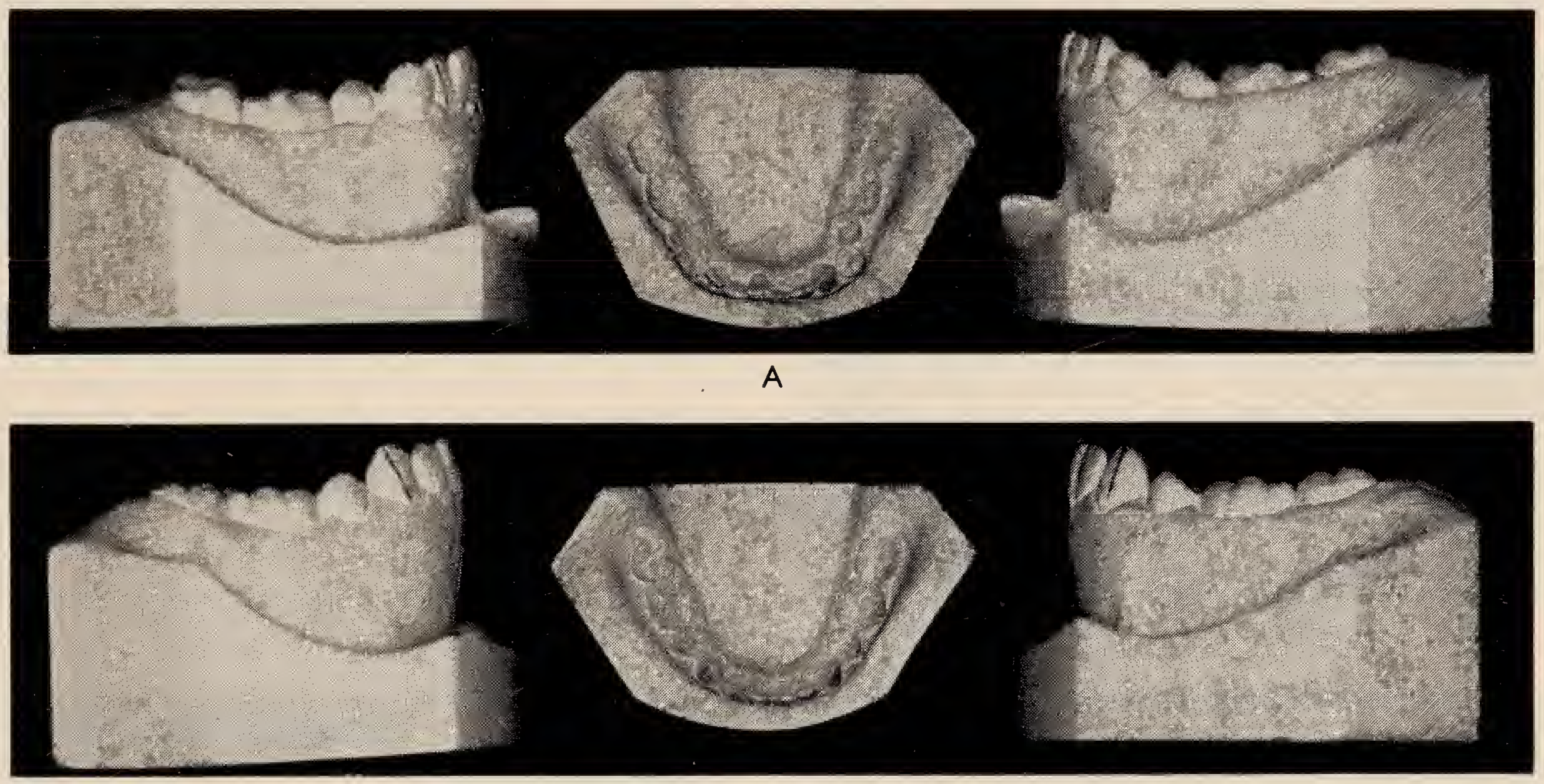
2. DISTAL DRIFTING

This may occur when space is created by:—

a. Distal Movement of Upper First Molars

The upper second premolars will usually drift distally at least half the distance moved by the first molars. This can occur even when the first

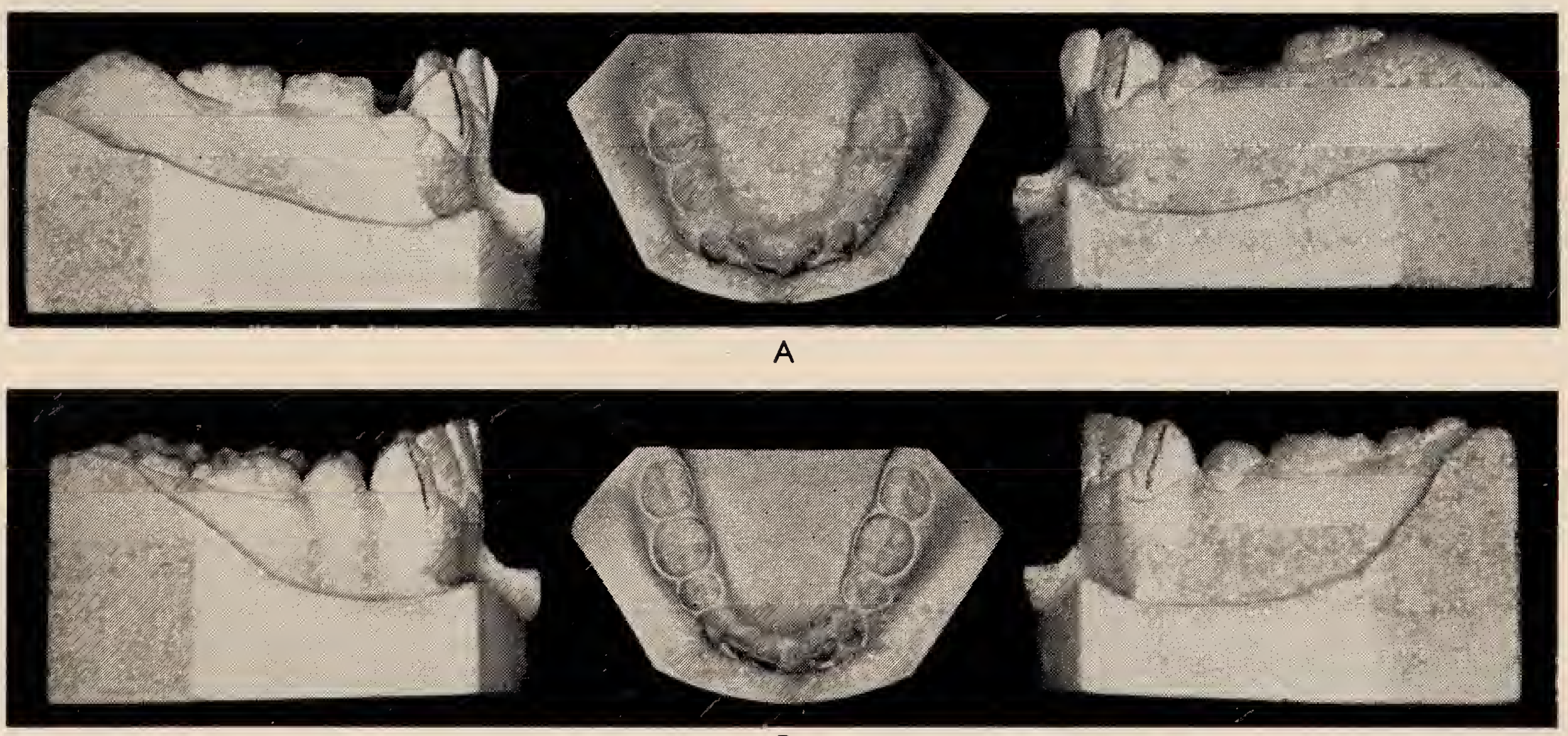
premolars are prevented from moving by the appliance (a case was shown to illustrate this). In some cases of limited distal movement of the upper first molars, improvement in alinement of the upper canines can occur naturally following the distal drift of the premolars (a case was shown to illustrate this).



A

B

Fig. 4.—Models of dentition of Patient R.P. A, Before treatment. B, Twenty-two months after extraction of all first premolars.



A

B

Fig. 5.—Models of dentition of Patient C.J. A, Before treatment. B, Ten months after extraction of all first premolars.

b. **Extractions**

Often considerable natural improvement in the alinement of the remaining teeth occurs following extractions to relieve crowding. If the space created by the extractions is more than adequate and observation shows that natural alinement is occurring, orthodontic appliances may prove to be unnecessary. This is more commonly seen in the treatment of the lower arch where mesial drift of the buccal segment occurs less readily (*Fig.* 4). If space is only just adequate the lower first molars may be banded and an ' ideal ' lower lingual arch fitted. This allows natural improvement in alinement of the teeth to

take place, but tends to minimize mesial drift and to ensure that any mesial movement of the first molars that does occur will have the effect of moving the instanding incisor(s) labially into alinement. It is presumably the resistance of the instanding incisor(s) to labial movement in the

Fig. 6.—Occlusal view of ideal lower lingual arch.

face of crowding (e.g., mesially- and buccally-placed canines) that minimizes mesial drift of the first molars, although maintenance of a constant intermolar width may be a contributory factor (*Fig.* 5).

An ideal lower lingual arch should be shaped into: (i) An ideal curve anteriorly; (ii) Contacting the instanding incisor(s) only; (iii) and be well free of the lower canines (*Fig.* 6).

A period of observation with the lower lingual arch in place may be followed in some cases by its removal if natural response has been good, or by commencement of active orthodontic treatment.

It is interesting to note the considerable distal drifting of unfavourably inclined lower canines, both crowded out from, and in the line of, the arch, and improvement in lower incisor alinement that can occur in some cases (*Figs.* 4, 5). It is likely that two factors are involved. Undoubtedly, a tooth crowded out, or malplaced, from the line of the arch is likely to receive a resultant force from the soft tissues acting on its outstanding buccal, or instanding lingual aspect to produce movement of the tooth if space is available. The extent to which this would effect tooth movement would depend on the width of the ‘ neutral zone ’. The other factor is contraction of the trans-septal periodontal fibres that re-form across the first premolar sockets. The fact that the somewhat upright lower canines in *Case* R.P. (*Fig.* 4) have drifted distally out of contact with the lower lateral incisors would seem to support this.

As the upper canines are retracted following the extraction of the upper first premolars, the upper lateral incisors will often drift distally if this movement is not prevented by the appliance (a case was shown to illustrate this). This movement is a particularly helpful one when the upper lateral incisor is displaced either palatally or labially, overlapping the central incisor, and when alinement of the incisors is to be carried out using a removable rather than a banded

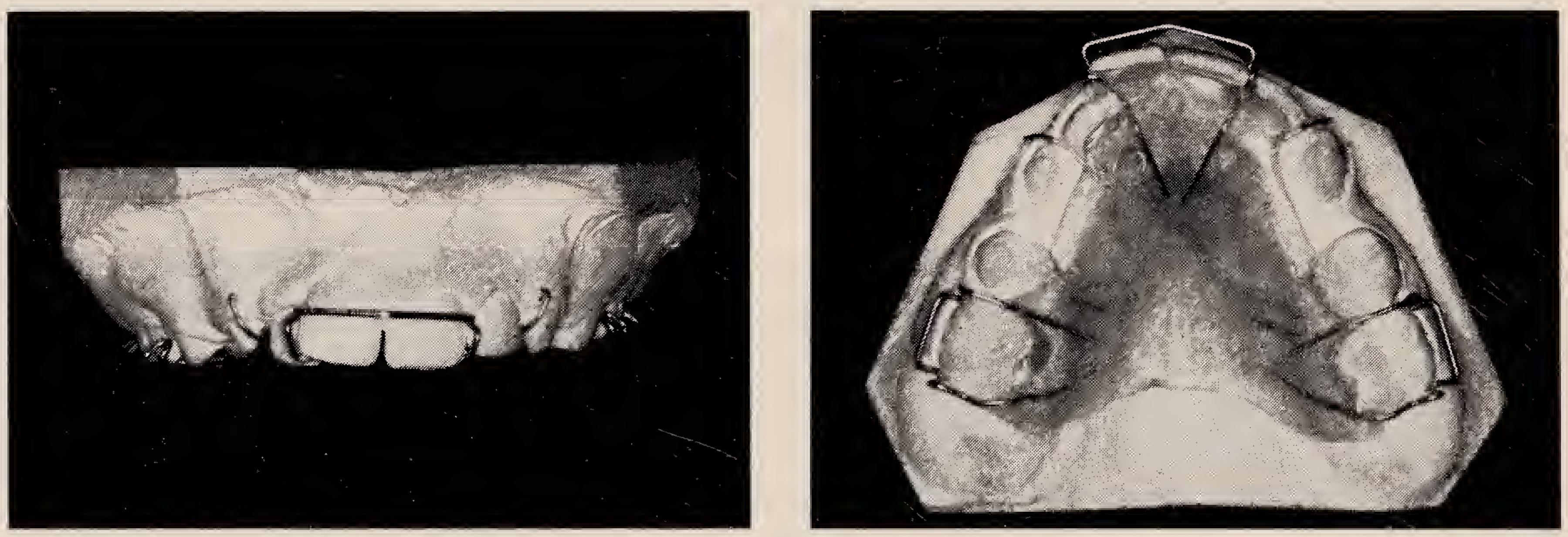


Fig. 7.—Occlusal and anterior views of upper removable appliance incorporating a combined Adams' crib on $\underline{1|1}$.

appliance. Consequently, a further modification of the Adams' crib, clasping both upper central incisors (*Fig.* 7), may be used to advantage on an upper removable appliance instead of a fitted labial bow. By smoothing the acrylic behind the upper lateral incisors, the distal drifting of these teeth can occur. The greatly improved retention that often results from the presence of the combined central incisor crib may itself justify its use, as it can do in a lower removable appliance. When space is critical, and the maximum anchorage is required from the incisors, its use may then be contra-indicated. It has the disadvantage in use of fracturing more frequently than the molar crib, possibly in those cases where a habit is formed involving displacing and replacing the appliance with the tongue. The crib can be strengthened by constructing the tags and the parts crossing the line of arch within soft stainless-steel tubing.

Obviously distal drifting must be associated with the presence of the trans-septal periodontal fibres, and its extent be related to the degree of crowding present, the inclination of the teeth, soft tissue, and occlusal factors.

SUMMARY AND CONCLUSIONS

1. A period of observation to assess the degree of natural response following extractions to relieve crowding is indicated in many cases, particularly in the treatment of the lower arch.

2. The design of appliances should be modified whenever possible so as not to prevent helpful tooth movements from occurring.

These conclusions arise from the fact that spontaneous tooth movements have the following advantages and consequently can save chair-side time:—

a. They do not use up anchorage (although mesial drift of the teeth behind the extraction spaces may still be a problem).

b. They appear to be free of any adverse apical movement—unlike orthodontic tooth movements.

c. The new tooth positions are likely to be stable.

Acknowledgements

I would like to thank Dr. Mills for his encouragement and advice in preparing this demonstration; Professor Ballard, Mr. McCallin, and Dr. Mills for permission to show cases treated at the Eastman Dental Hospital; Miss Snow for preparing the photographs and Miss Pickard for the tracings.

A CEPHALOMETRIC INVESTIGATION OF CHANGES IN LIP SEPARATION FOLLOWING RETRACTION OF UPPER INCISORS

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In patients with Class II, division 1 type of incisor relationship, one of the most conspicuous features is the separation of the lips.

These individuals seek treatment to remedy not only the protruding upper incisors, but also the inelegant lip appearance, a feature discussed by Stephenson (1961).

What improvement in the degree of lip separation can be expected as a result of retraction and alinement of the upper incisors?

In this study, the alterations in the habitual postural position of the lips and their separation were recorded cephalometrically both before and after completion of treatment and following a period of approximately nine months.

REVIEW OF LITERATURE

Jackson (1962), considered that the degree of incisor coverage by the lip is an indication of its function, especially in the case of a lower lip which exerts a controlling influence on the proclination of upper incisors.

Birch and Huggins (1963), using a cephalometric method, investigated upper lip position changes and found that there was a lengthening and thickening of the upper lip following retraction of upper incisors.

METHODS AND MATERIALS

Case Selection Factors

Cases accepted for this study were clinically and cephalometrically diagnosed as having a postnormal dental base relationship, with upper incisors proclined relative to the maxillary plane. The average age was 11 years 6 months. Cases were included only when their cephalograms showed the molars in occlusion, good definition of incisors, lips, and related anatomical landmarks, especially ANS and PNS. The patients in the post treatment analysis, had received treatment for a period of two years, plus or minus six months, and the space for incisor retraction had been provided as a result of bilateral extraction of appropriate dental units. The upper incisors had been retracted by removable and/or fixed appliances, anchorage being supported by intermaxillary or extra-oral traction where necessary. The cephalograms taken on completion of the treatment were accepted provided that they showed the same qualities as the initial films, and also metric evidence that the incisors had been retracted as a result of therapy. In this investigation forty-four cases were considered.

Cephalostat Recording Technique

A standardized cephalostat unit (Hallett, 1959) was used to produce true lateral cephalograms at the following stages:—

1. Before treatment.
2. After completion of treatment, including a standard post treatment retention period of six months.
3. At approximately nine months after completion of all appliance therapy.

Measuring Technique

A transparent plastic measuring grid inscribed with 1-mm. squares was used to orientate and measure the position of the upper incisors, upper and lower-lip position, relative to the fixed adjacent anatomical plane ANS–PNS. Measurements were made directly onto the film without the intermediate use of any other tracing substance, so avoiding tracing error described by Broadway, Healy, and Poyton (1962).

Presented at the meeting held on 11 October, 1965.

Measurements

If a cephalometric technique is to be satisfactory, the points from which linear changes are to be recorded (ANS–PNS plane), must be uninfluenced by the growth or treatment during the period of time covered by the series of observations.

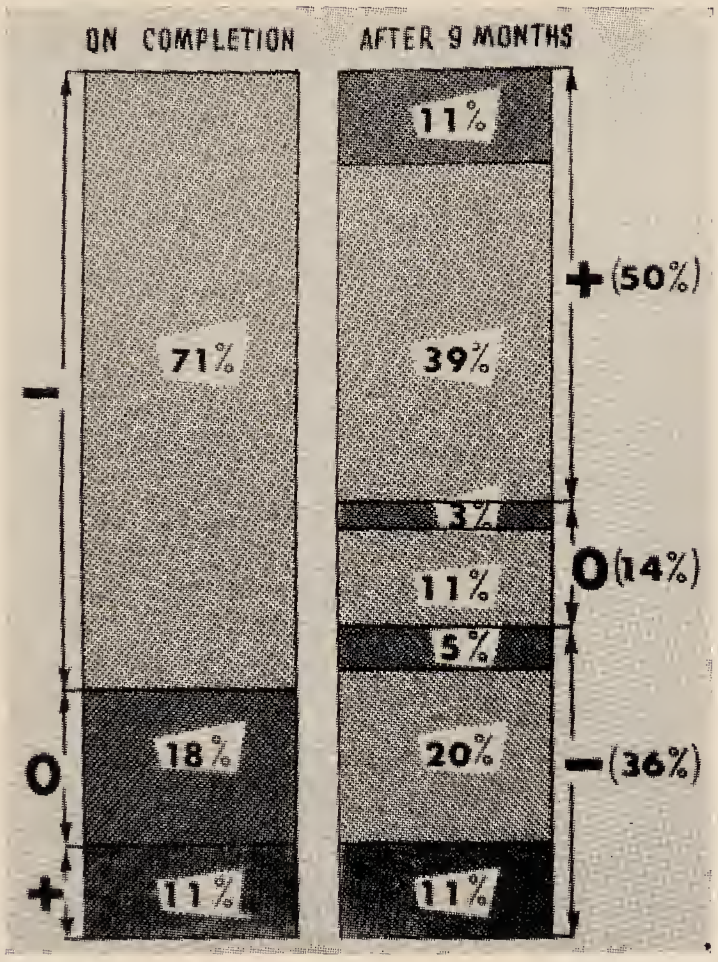

Fig. 1.—The first column shows the subjects arranged in groups which indicate, by means of prefixed signs and shading, whether their lip-separation had altered at the completion of treatment. The second column shows the alterations in these groups after nine months, and the differential shading of the contributions within each group relates them to their previous grouping at the completion of treatment. The percentage values shown are approximate to a ±1 per cent level for purposes of diagrammatic simplicity.

In this study, the following measurements were recorded:—

1. Changes in the position of upper incisors.
2. Vertical changes in upper and lower lip positions.
3. Changes in separation between upper and lower lips.

Accuracy

The following factors received special attention:—

1. Direct metric analysis on the films.
2. Same observer for all measurements; separate and independent recording of results.
3. Measurements by vertical vision over cephalometric viewer and grid.
4. Controlled lighting.
5. Standardized high-definition films.

Assessment of Accuracy

The inherent error in measuring technique was found to be within acceptable limits according to the duplicate determination formula of Dahlberg (1940), as described in previous work (Birch and Huggins, 1963).

RESULTS

The principle results are shown in *Tables I, II, and III* and in *Fig.* 1, and are self-explanatory.

Table I.—Cephalometric Assessment of Lip Separation at Completion of Treatment

Incisors

All cases showed that the upper incisors had been retracted (average 4·6 mm.)

Lip Separation

No change	18 per cent of cases
Reduced separation	71 per cent of cases
Increased separation	11 per cent of cases

Table II.—Cephalometric Review Nine Months after Treatment

Incisor Relapse

Average 1·8 mm. (occurring in 54 per cent of cases)

Lip Separation (compared with that at completion of treatment)

No change	14 per cent of cases
Reduced separation	36 per cent of cases
Increased separation	50 per cent of cases

Table III.—Overall Changes in Lip Posture when the Final Measurements are compared with the Pretreatment Figures

Lip Separation

No change	17 per cent of cases
Reduced separation	60 per cent of cases
Increased separation	23 per cent of cases

Assessment of Upper and Lower Lip Contribution to Lip Separation at Completion of Treatment

It was possible, by using the grid system, to determine the relative contribution of upper and lower lips in those cases where lip separation had decreased, and they were found to be as shown in *Table IV.*

Both upper and lower lips contributed to the reduced separation, either separately or together, by almost equal amounts.

Table IV.—Degree of Lip-share in Lip Separation Improvement

Upper and lower lips together	23 per cent
Upper lip only	25 per cent
Lower lip only	23 per cent
No improvement in lip separation	29 per cent

Relationship between Incisor Retraction and Lip Separation Values

The possibility of a correlation between the retraction value of upper incisors at completion of treatment and the improvement in lip separation was investigated statistically. The results,

however, were that no such correlation could be demonstrated for this group of subjects.

DISCUSSION

When treatment was completed, it was found that lip separation was reduced in 71 per cent of cases with an average improvement of 2·9 mm. In 11 per cent of cases there was increased lip separation, the other 18 per cent remaining unchanged. The average retraction of the incisors was 4·6 mm.

Overall changes (i.e., pretreatment lip separation compared with the results nine months after treatment) showed that a reduction in lip separation had occurred in 60 per cent of cases, a fall from the higher figure of 71 per cent found immediately after treatment.

CONCLUSIONS

These results, although on limited numbers, suggest that a reduction in lip separation did occur in many cases during treatment, but was only maintained by a proportion of them at follow-up. In some cases, lip separation actually increased following retraction of upper incisors in patients with Class II, division 1 type incisor relation. As yet, it is not possible to predict prior to treatment into which group the patients will fall.

Acknowledgements

The authors thank Mr. P. D. Bird, Radiologist, Liverpool Dental Hospital, for advice on cephalometry and Mr. S. Bailie, of Liverpool Dental School, for photographic reproductions.

REFERENCES

Birch, R. H., and Huggins, D. G. (1963), *Trans. europ. orthod. Soc.*, 309.

Broadway, E. S., Healy, M. J. R., and Poyton, H. G. (1962), *Trans. Brit. Soc., Orthodont.*, 9.

Dahlberg, G. (1940), *Statistical Methods for Medical and Biological Students.* New York: Interscience Publishers, Inc.

Hallett, G. E. M. (1959), *Trans. Brit. Soc. Orthodont.*, 1.

Jackson, D. (1962), *Brit. dent. J.*, **112,** 147.

Stephenson, J. C. (1961), *Trans. Brit. Soc. Orthodont.*, 95.

DISCUSSION

Professor D. P. Walther asked if the X-rays were taken when the patient was at rest? If so, how did they obtain the rest position?

Mr. R. H. Birch said that the teeth were together, the molars in occlusion, the lips at rest.

Miss June Murray asked whether the older patients had shown a greater percentage of reductions in lip separation?

Mr. R. H. Birch said they had not investigated this point particularly.

Mr. W. A. Nicol suggested that it might be interesting to correlate the incisors that had relapsed at the end of treatment with the degree of separation of the lips.

Mr. R. H. Birch said they had tried to correlate these factors, but the differences were so small it had not been possible in this group.

Mr. A. S. Lewis asked if the authors had done any repeat radiographs on the same people? Also, had they considered having a control group to see how lip position changed over a similar age period?

Mr. R. H. Birch agreed that they had. The degree of error obtained as a result of using the double determination formula had been small and was considered to be acceptable.

They had not felt they needed a separate control group.

Mr. J. D. McEwen asked if removable appliances incorporating anterior bite planes had been used during treatment? If this was so, what effect had the bite planes had on the relationship of the lips to the teeth?

Mr. D. G. Huggins said the majority of the appliances had bite planes incorporated, but he did not think this influenced the degree of retraction of the upper incisors.

Mr. H. E. Wilson asked could the authors give any indication how the increase of lip separation took place? Did they, in their investigations, eliminate any temporary nasal obstruction, because this would obviously affect lip posture?

Mr. D. G. Huggins said, on the matter of increase in separation, he had been most intrigued. He had thought perhaps the lip changed shape following retraction of the incisors, becoming oval in section, instead of circular or vice versa. This would reduce the length of the lip.

Mr. R. T. Broadway said he, too, had been interested in the 11 per cent of the cases showing increase in separation of the lips. Was there any correlation between this and bringing forward the upper incisor apices during retraction of the upper incisors?

Mr. R. H. Birch said they had not measured the movement at the root apices of the incisors since they had been rather confined in their measurements.

Mr. R. E. Rix asked whether, among the patients whose lips separated more, the Frankfurt-mandibular-plane angle was excessively high?

Mr. R. H. Birch said they had tended to keep the assay to its narrowest aspects. They had not considered other changes in the skeletal formation on the cephalogram.

Mr. J. D. McEwen asked if patients got any lip exercises or myofunctional therapy?

Mr. R. H. Birch said not generally, no.

Mr. J. C. Stephenson asked if any correlation had been found between those cases showing the most marked improvement and those with the widest separation of the lips at the beginning, or with those who initially were still sucking thumbs or fingers?

Mr. D. G. Huggins said there had been no patients thumb-sucking when treatment was commenced.

The President asked if any of the patients achieved lip contact and, if so, did they keep it?

Mr. R. H. Birch said that there were only two cases in their study where, once the lips had come into contact, they remained so.

ORTHODONTIC TREATMENT FOR ADULT PATIENTS

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INTRODUCTION

It is generally considered that provision of orthodontic treatment should be limited to children, that is those under the age of 18 years. These views flourished because, for many years, malocclusions were treated as soon as they appeared, coupled with the ideas of Friel (1938) that treatment carried out during a growth spurt was more likely to lead to a stable result.

Fletcher (1958) showed that orthodontic treatment could be completed in the minimum of time if commenced in the 11–12 year age-group. Orthodontic treatment is based on gentle pressure on the teeth, producing bone apposition and resorption; processes that are continuous throughout life. Therefore, there appears to be no biological reason to confine treatment to a particular age-group, for as Gottlieb (1931) stated, ' Man wakes up with a new skeleton every morning '.

Table I

1. From general practitioners for correction of irregularities of teeth/periodontal conditions.
2. Periodontal department when the gingival condition was poor, especially in the lower labial segment; or in temporomandibular joint disturbances.
3. Conservation department when crown or bridge work was envisaged; uprighting abutments and closing spaces.
4. Prosthetic department when partial dentures were to be made.
5. Oral surgery department—alinement of impacted upper canines or impacted lower molars.
6. Parents of patients under 18 years requesting treatment of irregularities of their own teeth.
7. Psychiatric or others.

REVIEW OF LITERATURE

The history of carrying out orthodontic treatment for patients over the age of 18 years is remarkable. In 1858, Peebles declared that he preferred to treat patients over the age of 25 years. In 1880, Kingsley stated that there was no age limit at which orthodontic treatment should be commenced, and in 1904, Hugo Jackson made successful claims of orthodontic treatment in adult patients. Among recent authors, Stein (1934), Offer-Spitz (1945), Goldstein (1953), Granerus (1956), and Botzwadze (1957), have presented illustrated case reports of successful orthodontic treatment in adult patients. In view of this, the authors considered it reasonable to treat patients over the age of 18 years, who were referred by colleagues.

INDICATIONS FOR TREATMENT IN ADULT PATIENTS

Despite the efforts of modern dentistry, many adult patients have irregularities of occlusion, and orthodontic treatment can play an important part in their rehabilitation. Those cases under discussion were referred from the sources shown in *Table I.*

In all cases the patient was fully acquainted with the procedure necessary to achieve improvement of the occlusion, as it was felt that adult patients would be less likely to tolerate appliances than children. The majority of patients considered that they were receiving special consideration, as the opinion had been widely expressed that only in children could teeth be repositioned.

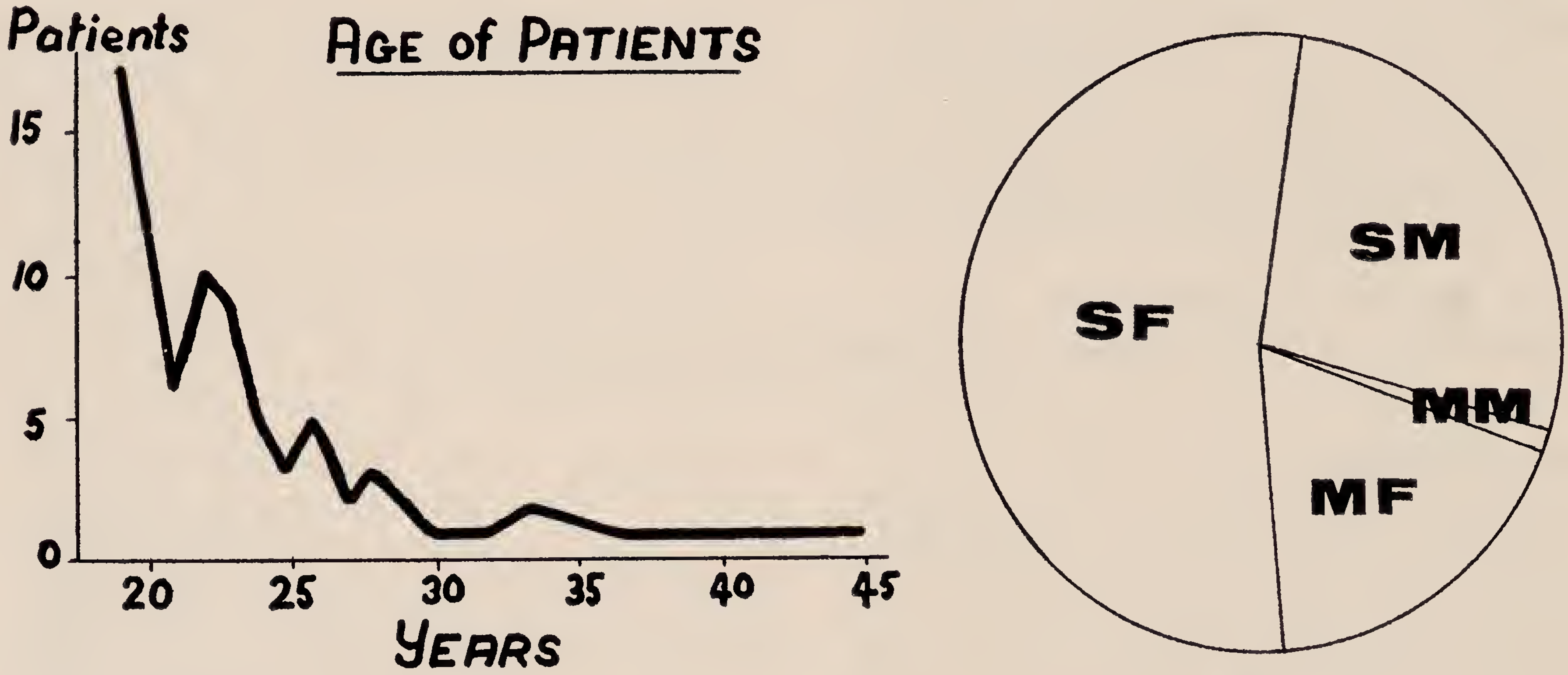
METHODS AND MATERIALS

The average age of the patients was 23 years 3 months (*Fig.* 1A). There were 86 patients, 62 female and 24 male, considered in this survey (*Fig.* 1B). Approximately a quarter of the women were married; one male was married, four single women married immediately after

Presented at the meeting held on 11 October, 1965.

treatment and one postponed her wedding to allow completion of treatment. The patients had been referred from sources which are shown in *Table II.*

The patients being considered had caries controlled, and, except in cases referred from the department of periodontology, had a satisfactory gingival condition.



A B

Fig. 1.—A, Ages of patients under consideration. B, Marital status and sex of patients. S, single; M, married; F, female; M, male (e.g., M M, married male).

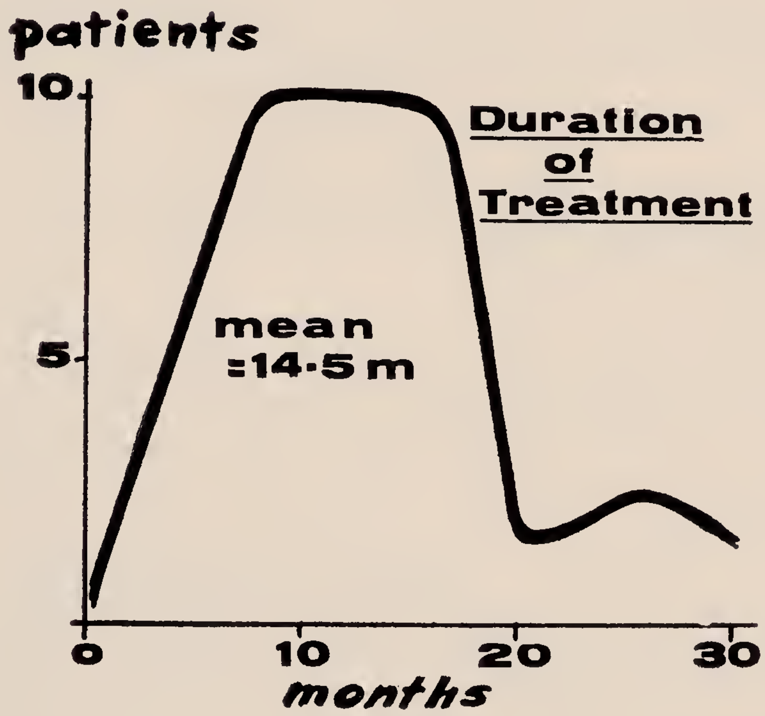


Fig. 2.—Graph to show duration of treatment.

Table II

1.	General practitioners	41
2.	Department of periodontology	21
3.	Department of conservative dentistry	10
4.	Department of oral surgery	11
5.	Miscellaneous	3
		86

The patients were examined, and an assessment of their condition made with the help of radiographs and models of the mouth. The findings are shown in *Table III.*

Table III

Type of Incisor Relationship

Class I,	with crowding	7
Class II,	division 1	19
Class II,	division 2	4
Class III,	including some prior to surgery	7
Local irregularities (for correction prior to bridge/denture replacement or misplaced canines)		49
		86

Table IV

	Extraction of teeth required in	40 cases
1.	Removable appliances only	55 cases
2.	Fixed and removable combined upper/lower arch	19 cases
3.	Fixed appliances, upper or lower arch	11 cases
4.	Appliances not required	1 case

Treatment plans were drawn up and *Table IV* gives an indication of the treatment carried out.

RESULTS

Treatment continued over a mean period of 14½ months, there being a range of 2–60 months (*Fig.* 2).

Seventy-six patients of the original 86 completed the course of treatment, and the results were considered to be good in all but 4 of these patients.

The periodontal condition and oral hygiene of the patients who completed treatment was

satisfactory, there being a considerable improvement in those who were referred from the department of periodontology.

The degree of relapse was assessed as none or slight in all cases over a minimum period of 6 months; 3 patients are wearing permanent retainers.

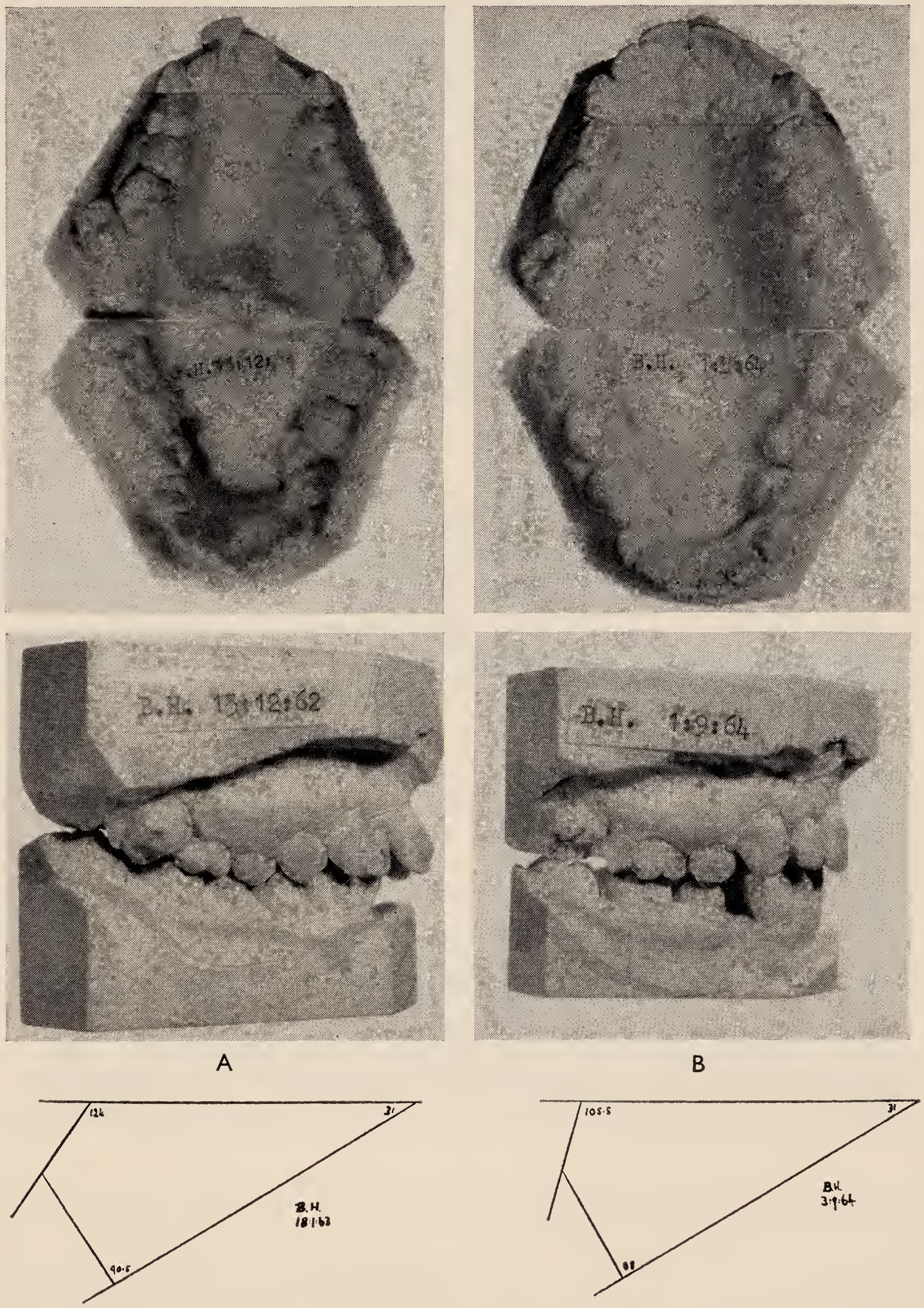
The following case reports will illustrate the type of condition being considered and the degree of improvement achieved.

CASE REPORTS

Case 1

B.H., born 3 *August*, 1936.

This patient attended the department of periodontology complaining of halitosis and bleeding of the gums. She had a marginal gingivitis. Treatment was planned to allow resolution of the gingival inflammation. This consisted of a general scale and polish, followed by orthodontic treatment to aline the teeth in the upper and lower arches.



A B

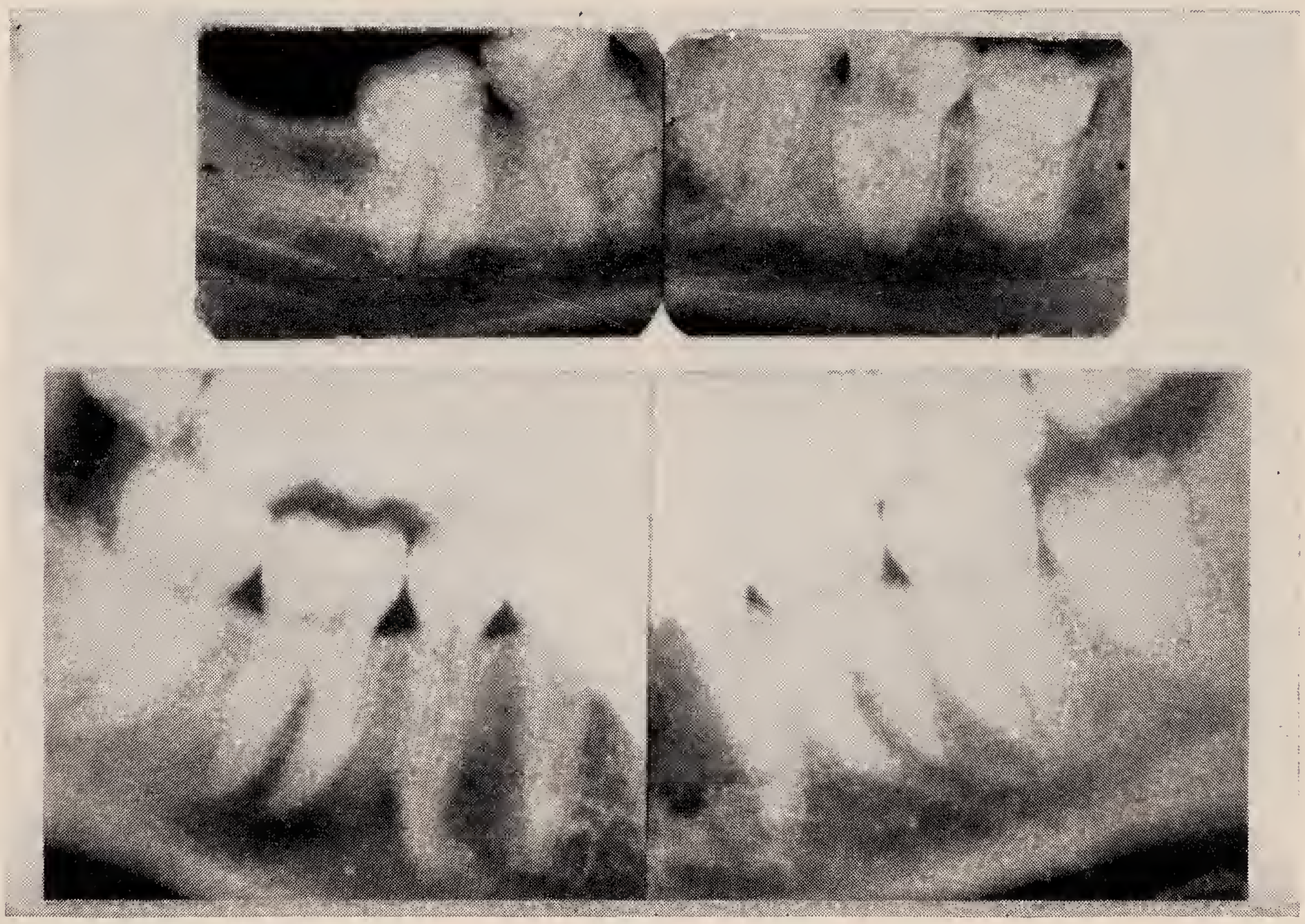
C

Fig. 3.—*Case* 1. A, Record models before treatment. B, Record models after treatment. C, Diagrammatic representations of lateral skull radiographs before and after treatment.

The orthodontic department found all teeth were present except $\overline{8|}$ (*Fig.* 3A). Carious lesions had been restored, the oral hygiene was satisfactory, but gingival condition poor. Teeth in both upper and lower arches were crowded. There was a Class II, division 1 type of incisor relationship with a mild Class II dental

To relieve crowding and reduce the overjet, it was decided to extract $\frac{74|4}{4|4}$ and following this, use upper removable and lower fixed appliances supporting upper arch anchorage with intermaxillary and extra-oral traction.

A



B

Fig. 4.—*Case* 1. Radiographs to show supporting bone. A, Incisor area—before treatment (*lower* film), after treatment (*upper* film). B, Molar area—before treatment (*lower* film), after treatment (*upper* film).

base relationship. The maxillary-mandibular-plane angle was above average.

The soft-tissue pattern was one of incompetent lips and tongue to lip resting posture. Swallowing was carried out with the teeth apart and was accompanied by circumoral muscular contraction.

Treatment was commenced on the 7 January, 1963, the patient being 26 years of age, and appliances withdrawn in September, 1964, all tooth movements having been completed within 21 months. Night-time retention continued for a further six months. It will be seen from record models and the tracings of

cephalograms that the upper anterior teeth were retracted (*Fig.* 3B, C).

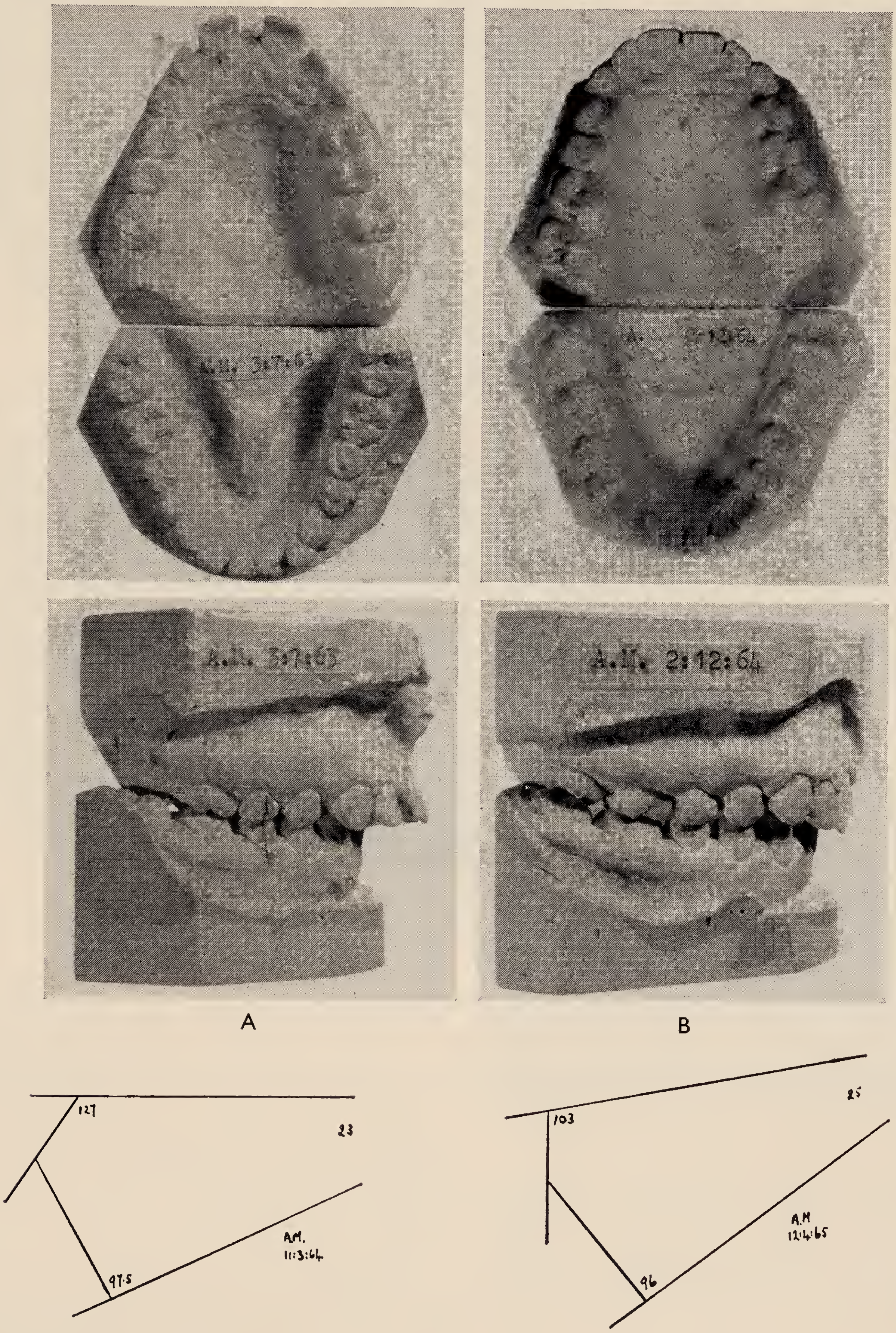
Radiographs show bone pattern before and after treatment (*Fig.* 4).

The space in the $\overline{4}|$ area was unavoidable, as extraction of this tooth was complicated and infection of the area ensued. Tooth movement in this area came to a standstill. The bone pattern remains irregular, but clinically there are no symptoms. The incisor relationship is stable.

Case 2

A.M., born 24 *August*, 1942.

The patient was 20 years old when she attended on 9 August, 1963, for diagnosis. Examination showed that all teeth of the normal series were present except



C

Fig. 5.—*Case* 2. A, Record models before treatment. B, Record models after treatment. C, Diagrammatic representations of lateral skull radiographs before and after treatment.

$\frac{6|6}{8|8}$; $\underline{8|8}$ were unerupted (*Fig.* 5A). Caries was controlled and oral hygiene and gingival condition were adequate. There was a Class II, division 1 type of incisor relationship, a noticeable feature being the diastema between $\underline{1|1}$. Dental base relationship was Class II.

The lips were incompetent and during swallowing the teeth were in occlusion, but the tongue oozed between the upper and lower incisors to make contact with the contracting lip musculature.

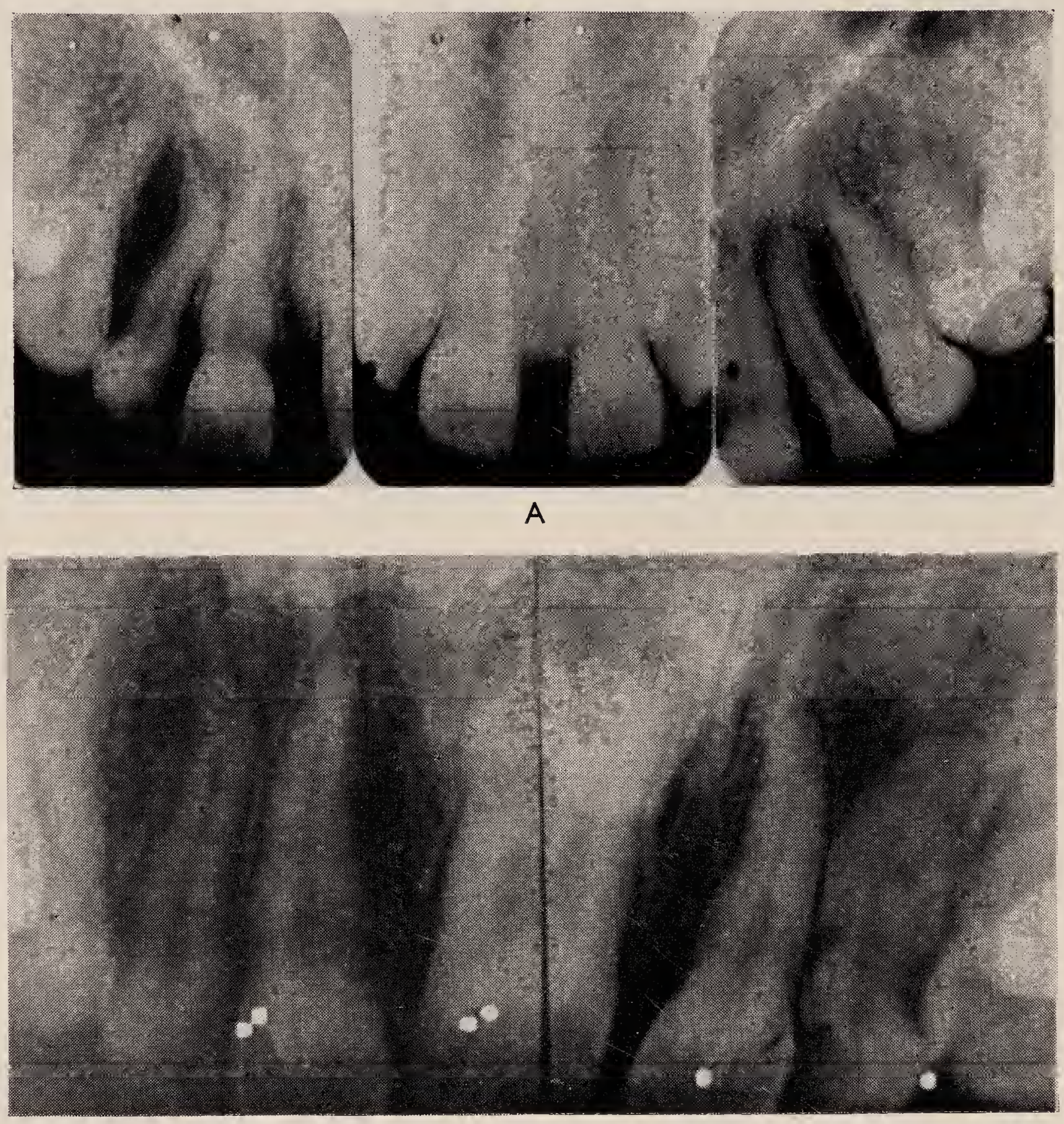
It was decided to retract the upper anterior teeth using a removable appliance to a position where they would come under control of the lower lip. In March, 1964, an upper removable appliance of the Robert's retractor design was fitted and the labial bow activated. During December, 1964, impressions for record models were taken (*Fig.* 5B). In February, 1965, the patient was again seen and in view of the previously noted adverse soft-tissue pattern, continuation of night-time retention was advised. Tracings show the degree of incisor retraction (*Fig.* 5C). Radiographs show bone pattern before and after treatment (*Fig.* 6).

Case 3

A.S., born 13 *December*, 1938.

This patient was first seen in 1959 when she was 20 years of age, and complained of missing $\underline{3|3}$, which adversely affected her appearance (*Fig.* 7A). The canine teeth were assessed as favourable for alinement in the arch, and were exposed in the spring of 1959, at the same time holes were drilled in the tips of the teeth to allow purchase for orthodontic wires.

In December, 1959, $\underline{6|6}$ were extracted and a removable appliance was fitted to retract $\underline{54|45}$ as there was insufficient room for accommodation of $\underline{3|3}$.



A

B

Fig. 6.—*Case* 2. Radiographs to show supporting bone A, before treatment, B, after treatment.

In February, 1960, there was sufficient space in the appropriate area of the arch to accommodate $\underline{3|3}$, and active movement of these teeth could have been commenced. However, the patient spent two months in Holland. In June, 1960, an appliance with lateral arms was fitted aiming to accelerate $\underline{3|3}$ eruption.

The record model of 5 March, 1962, shows $\underline{3|3}$, suitably alined, following treatment which lasted for 20 months (*Fig.* 7B). Radiographs show the periapical condition of $\underline{3|3}$ (*Fig.* 7C).

Case 4

R.J., born 12 *November*, 1941.

The patient was first seen when 20 years old, in May, 1962, at the request of the periodontal department. The lower second and third molars were tipped mesially, $\frac{6|6}{6|6}$, having been extracted. The overbite and overjet were reduced, and there was a Class III dental base relationship, the maxillary-mandibular-plane

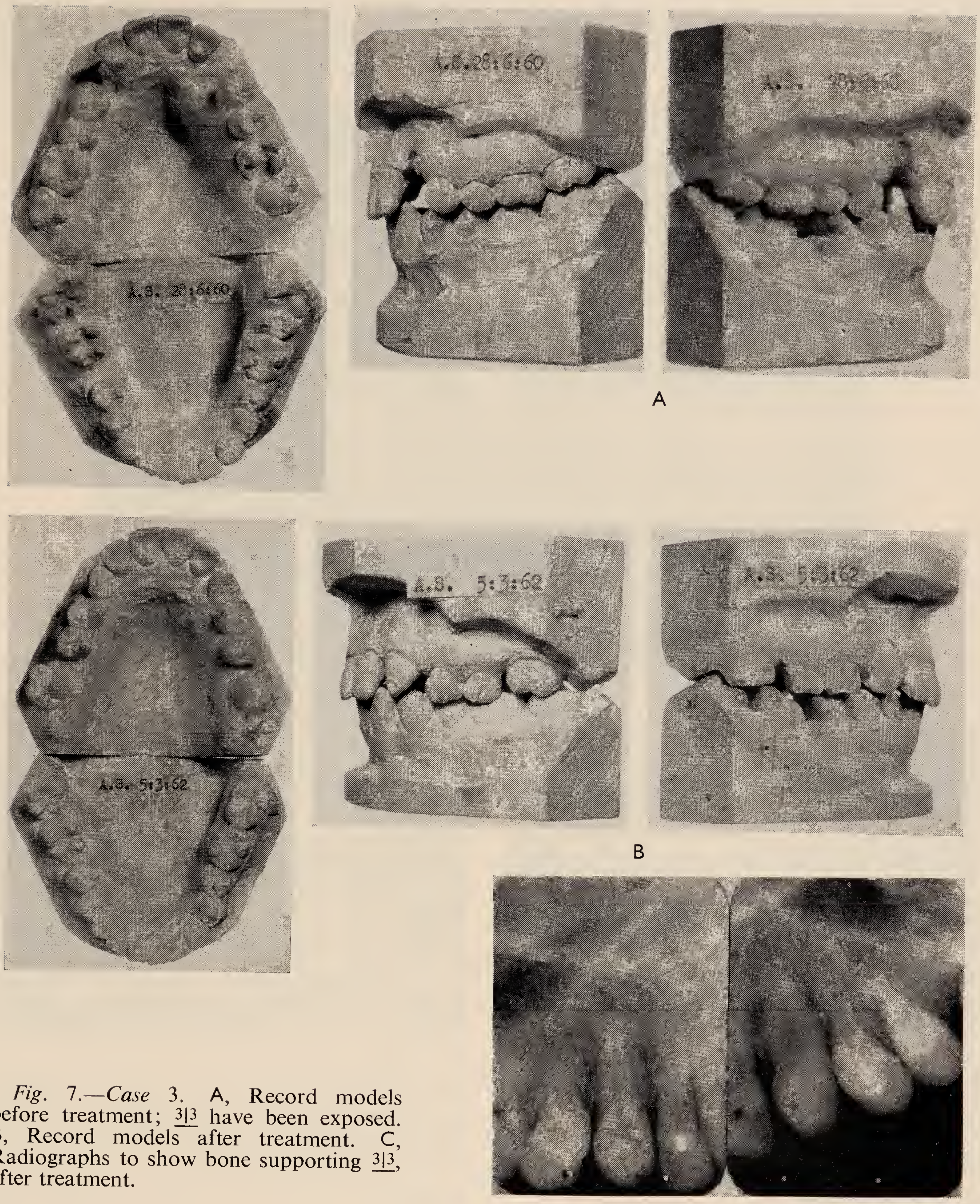


Fig. 7.—*Case* 3. A, Record models before treatment; $\underline{3|3}$ have been exposed. B, Record models after treatment. C, Radiographs to show bone supporting $\underline{3|3}$, after treatment.

angle being average. With the aid of a lower fixed appliance the $\overline{87|78}$ were uprighted, treatment continuing over a period of 15 months. The periapical condition before and after is illustrated (*Fig*. 8).

Case 5

K.L., born 2 *February*, 1923.

This patient first attended in March, 1960, as he was concerned regarding his occlusion.

Examination showed that he was in possession of an unserviceable upper partial denture. The overjet was reversed and overbite increased, the lower teeth completely concealing the uppers when in occlusion (*Fig*. 9).

With the aim of improving the incisor relation, an upper fixed appliance activated to procline the upper labial segment was fitted. A lower appliance was inserted at the same time in order that the upper teeth might be disengaged from the lower.

During March, 1961, that is after 12 months' treatment, the appliances were withdrawn and partial upper and lower dentures were fitted by the prosthetic

department. It was intended that the upper denture should support the upper labial segment, but in error this was not done. Fortunately, the incisor relation has remained stable. *Fig.* 10 shows pre- and post-treatment appearance.

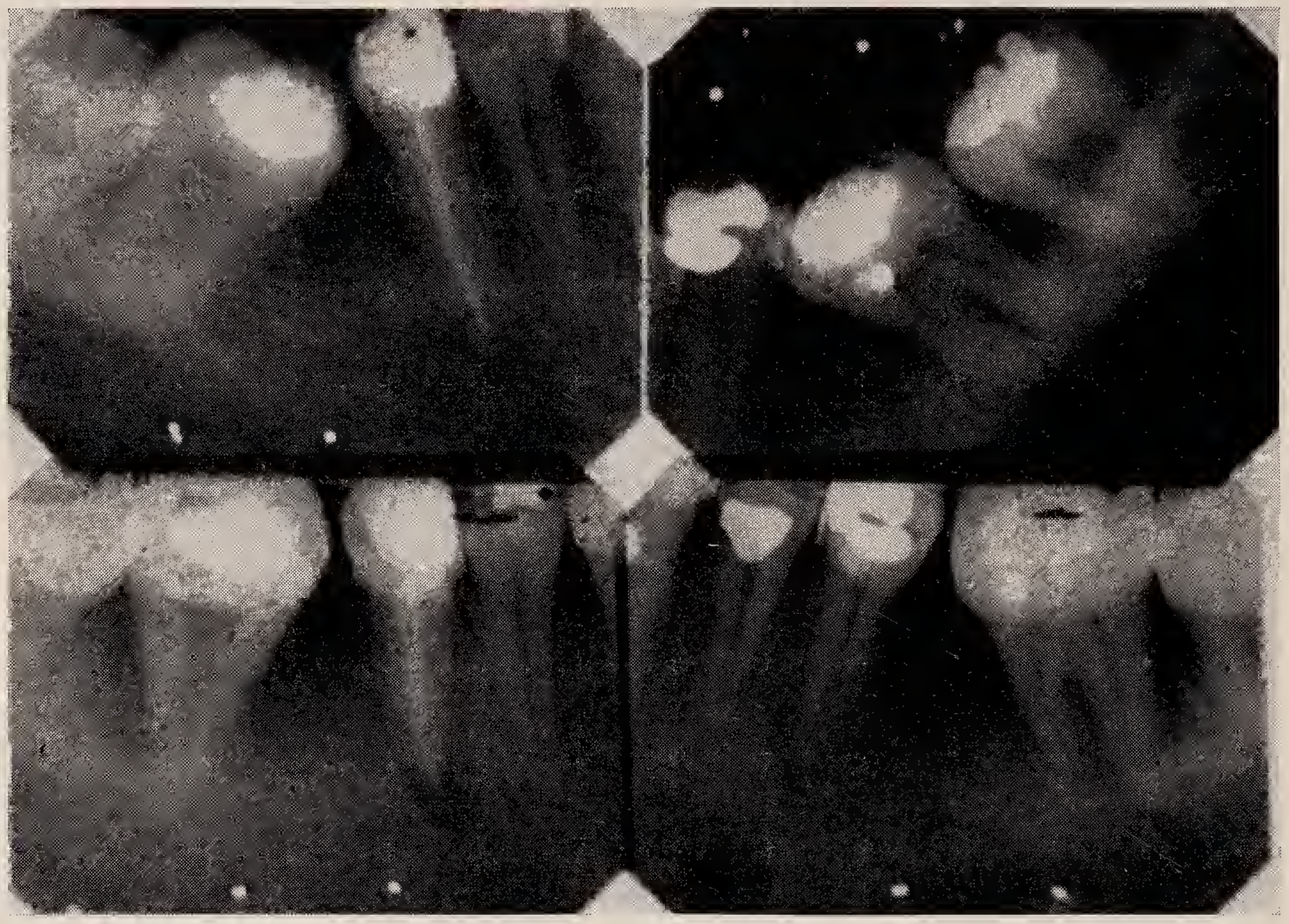
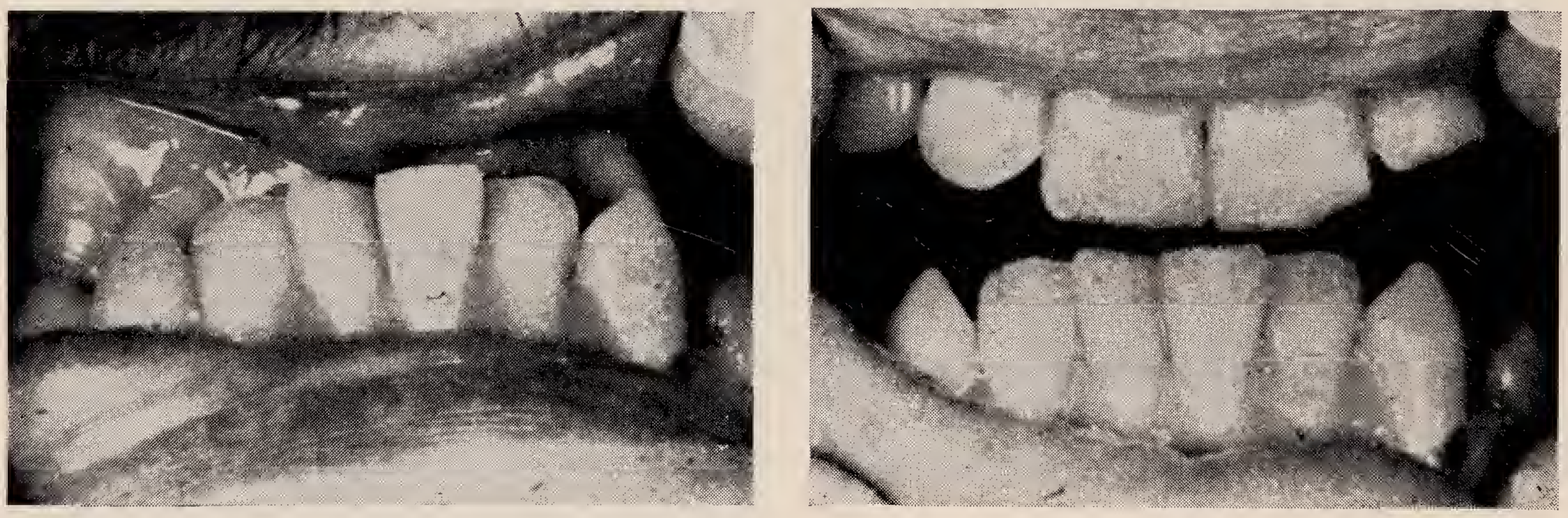


Fig. 8.—*Case* 4. Radiographs to show bone supporting $\overline{87|78}$ before (*upper*) and after (*lower*) treatment.



A B

Fig. 9.—*Case* 5. A, Anterior teeth in occlusion before treatment. B, With mouth open before treatment.

DISCUSSION

Since the commencement of this survey, it has become apparent that treatment of adult patients is a practical proposition. It has been shown that treatment duration is not appreciably different from those in the teen-age group. A considerable improvement in dental health can be experienced by these adult patients, and other dental work can be facilitated. The outcome of treatment for these patients is an improvement in mental and physical well-being.

There are certain advantages in treating adult patients; for instance, one does not rely on facial growth to enhance the result—definite decisions regarding prognosis are justifiable as the main variant has been removed.

The patients in this study were found to be extremely co-operative, having a more serious attitude toward treatment than the average 11-year-old.

There are indications that a large number of patients could benefit from orthodontic treatment, as we are able to offer help to periodontologist, oral surgeon, and prosthetist. Possibly with the increase of public awareness in the dental field, this treatment will be sought after. The authors hope that this communication will encourage colleagues to undertake this particular type of work.

SUMMARY

It is shown that adult patients can be successfully treated within periods not vastly different from those treated in the generally accepted age range.

Eighty-six patients who had been referred for orthodontic treatment were treated, and, of these, 76 completed a course of $14\frac{1}{2}$ months average duration with no adverse change in the supporting tissue and no increase in tooth mobility, which might have indicated loss of alveolar support.

Acknowledgements

The authors gratefully acknowledge the loan of the case records of patients treated by Mr. J. S. Rose, which were used to supplement those treated by them, also assistance from colleagues at the London Hospital, and Liverpool Dental Hospital. We are also grateful to Mr. S. Baillie, of the Photographic Department of the Liverpool University School of Dental Surgery, for his help with the preparation of diagrams and photographs used in this communication.

A B

Fig. 10.—*Case* 5. A, Appearance before treatment. B, Appearance after treatment.

REFERENCES

Botzwadze, B. L. (1957), *Dent. Abstr. N.Y.*, **3,** 330.
Fletcher, G. G. T. (1958), *Dent. Practit.*, **9,** 31.
Friel, S. (1938), *Dent. Rec.*, **58,** 233.
Goldstein, M. C. (1953), *Amer. J. Orthodont.*, **39,** 400.
Gottlieb, B. (1931), *Wien. Klin. Wschr.*, **44,** 1445.
Granerus, R. (1956), *Trans. europ. orthod. Soc.*, 141.
Jackson, V. H. (1904), *Orthodontics.* Philadelphia: J. B. Lippincott Co.
Kingsley, N. W. (1880), *Oral Deformities.* New York: Appleton & Co.
Offer-Spitz, A. (1945), *Amer. J. Orthodont.*, **31,** 391.
Peebles, H. E. (1858), *Amer. Dent. Rev.*, **2,** 148.
Stein, S. H. (1934), *Dent. Cosmos*, **76,** 611.

DISCUSSION

Mr. D. H. Oliver asked Mr. Huggins whether he was right in assuming the majority of his cases wore their appliances at night only. Snag number one was wearing appliances by day: most people were out in business, and that was a very major drawback.

Mr. B. B. J. Lovius said they had found that patients who wore appliances at night-time only, tended to have social and other engagements which precluded the use of the appliance on these occasions, resulting in the appliance being worn less and less. It was better to get the treatment completed, using appliances which they knew patients were wearing all the time, rather than give ones which possibly they might not wear at all.

The President said he always insisted on the patients wearing the plate all the time. He thought that if one started off by painting a black picture and saying that they had got to wear it all the time, the patients would not go into it lightheartedly, they knew the worst, and if one could relax later on it was an encouragement to keep them going.

He asked if Mr. Huggins used Paul's tubing or transparent elastic to retract incisors?

Mr. D. G. Huggins said yes, they did use Paul's tubing in the department, but not for any of these cases.

Mr. H. E. Wilson said treating adults was one of the most satisfying forms of treatment. They came along, they assumed their responsibility, and usually their percentage was much higher of completed cases in adults than in children.

Mr. F. Allan said that that part of treatment requiring readily visible appliances could be left until the end of treatment. With careful thought several tooth movements could be carried out simultaneously without using an ' omnibus ' appliance with twenty springs. Fixed and removable appliances could be combined. Treatment of adults did not necessarily take longer than with children.

Mr. D. G. Huggins said they had used multiband appliances and patients had been happy with them.

Mr. P. R. W. Coyle said his experiences had been much the same with regard to wearing appliances full time. One patient, whom he remembered quite clearly, had been a lady of twenty-four years, whose treatment proceeded very slowly. She had become pregnant during treatment, and the tooth movements proceeded remarkably quickly thereafter. Since termination of pregnancy, however, the tooth movements have, once again, been very slow.

Mr. D. G. Huggins thanked Mr. Coyle; he said he had not had any cases in a similar position.

Mr. J. D. McEwen said he had two questions: periodontal involvement did result occasionally; he had been worried about cases from the periodontal department of the hospital. Did Mr. Huggins rotate upper lateral incisors in adults? If so, for how long?

Mr. D. G. Huggins said they had not noticed any resorption following treatment. They had rotated upper lateral incisors. One of these patients was one of the group wearing a permanent retainer.

AN ELECTROMYOGRAPHIC INVESTIGATION AND SURVEY OF CLASS III CASES

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INTRODUCTION

It has been recognized for some considerable time that the Angle's Class III group of malocclusion includes a number of different types and many attempts have been made during the past years, to divide this group of malocclusion into its various types. Schwartz (1961) divided the group into those in which a 'forced bite' occurs, due to the axial inclination of the anterior teeth and those with abnormal growth of the mandible without a 'forced bite'. The division into a group showing a true mandibular prenormality and those showing anterior relationship of the mandible resulting in a postural prenormality is generally accepted. Further subdivisions of these two groups have been suggested by various authors, Blyth (1958), Schwartz (1961).

The aetiology of the postural Class III has been discussed by Ballard (1955), who suggested that the mandible is in an anterior relationship to the maxilla, as a result of a reflex activity on the part of the patient to avoid an edge-to-edge incisor contact. The value of electromyography in assessing the maxillary-mandibular relationship has been mentioned by several authors—Tulley (1953), Campbell (1954), Ballard (1955), Greenfield and Wyke (1955). It was therefore decided to carry out an electromyographic investigation on a group of Class III occlusions, to see whether those who had an anterior relationship of the mandible could be differentiated on electromyographic grounds from those who had a normal relationship of the mandible. Most investigations have used a purely subjective method to assess the electromyographic patterns but in this survey an attempt has been made to put this on a numerical basis (Perry and Harris, 1964).

MATERIAL

Forty cases with a Class I occlusion with normal overbite and overjet were investigated electromyographically to provide a group for comparison. This was divided equally into adults (those over 16) and children (those under 16) in order to ascertain whether there was a difference in muscular activity between the adult and the child group.

Electromyographic investigations were also carried out on 32 Class III cases all of whom had a Class III incisor relationship and these were divided clinically into those who postured into an anterior relationship and those who did not.

A longitudinal survey of 20 Class III cases of all types was conducted in order to assess the changes in the electromyographic patterns before, during, and after orthodontic treatment, and up to three years out of retention.

ANATOMY AND PHYSIOLOGY

In order to clarify the interpretation of the electromyographic records a short résumé of the anatomy and physiology is included.

The temporal and masseter muscles, both of which are superficial, can be divided anatomically into two parts. The temporal muscle is divided into the anterior fibres which are more or less vertical and run from the temporal fossa downwards to the coronoid process, and the posterior fibres which run horizontally forwards to the coronoid process (Sicher, 1965). The contraction of the posterior fibres will move the jaw posteriorly and the anterior fibres will elevate the jaw (*Fig.* 1). Similarly, the masseter muscle can be divided into the superficial fibres which

Presented at the meeting held on 13 December, 1965.

pass downwards and posteriorly at 45° from the zygomatic arch to the ascending ramus and lower border of the mandible, and the deep part whose fibres pass vertically down to be inserted into the lateral aspect of the ascending ramus. The

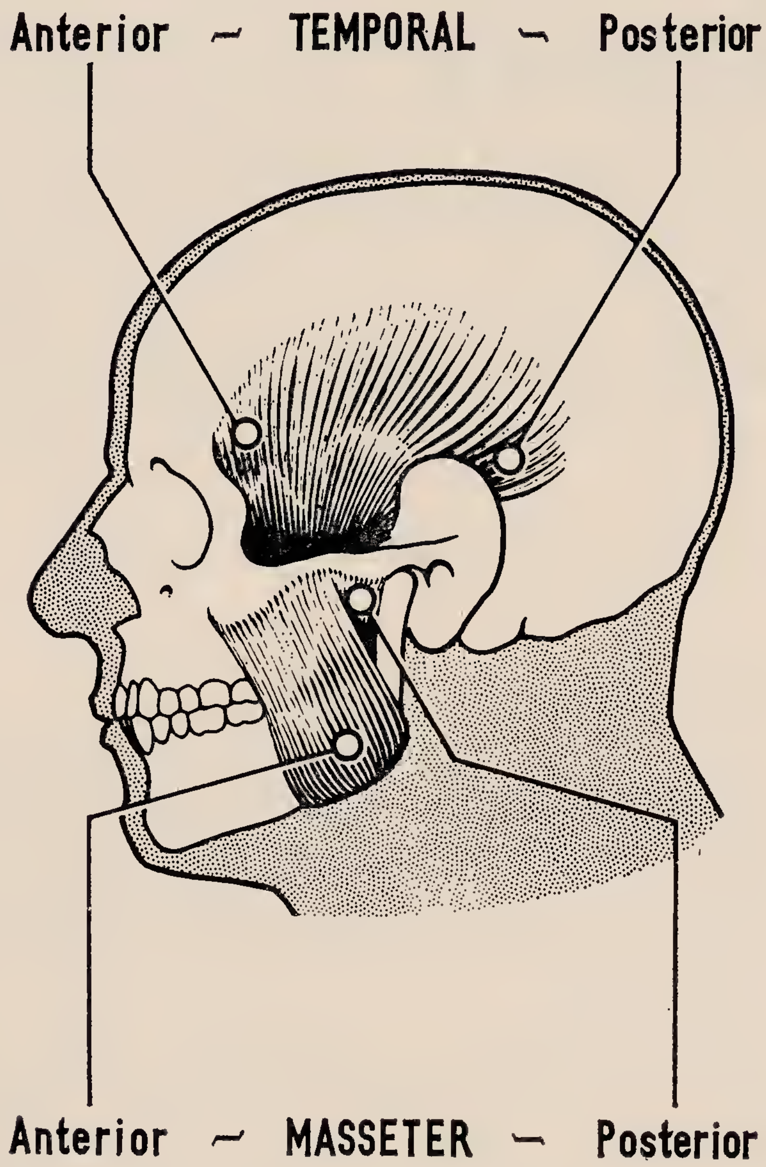

Fig. 1.—A diagram illustrating the direction of the muscle-fibres and the electrode positions.

superficial fibres will elevate and move the jaw anteriorly and the deep fibres will elevate the jaw (*Fig.* 1). The superficial and deep parts of the masseter muscle in this paper will be referred to as the anterior masseter and posterior masseter respectively.

Each muscle is composed of many muscle-fibres functionally grouped together into motor units. A motor unit consists of a single motor neuron whose axon divides peripherally to innervate a number of muscle-fibres. The number of muscle-fibres supplied by a motor neuron varies in different parts of the body but in the temporalis muscle it is approximately in the ratio 1:900 and in the masseter muscle 1:600 (Carlsoo, 1958). When a muscle-fibre contracts there is a change in its electrical potential and this action potential, as it is called, can be picked up using suitable electrodes. The action potentials are amplified and are recorded by means of an ink-pen writer or by means of sensitive mirror galvanometers and ultra-violet light recording on photographic paper (*Fig.* 2).

METHOD

The electromyographic investigations were carried out using the standardized technique of Greenfield and Wyke (1956). Unipolar suction

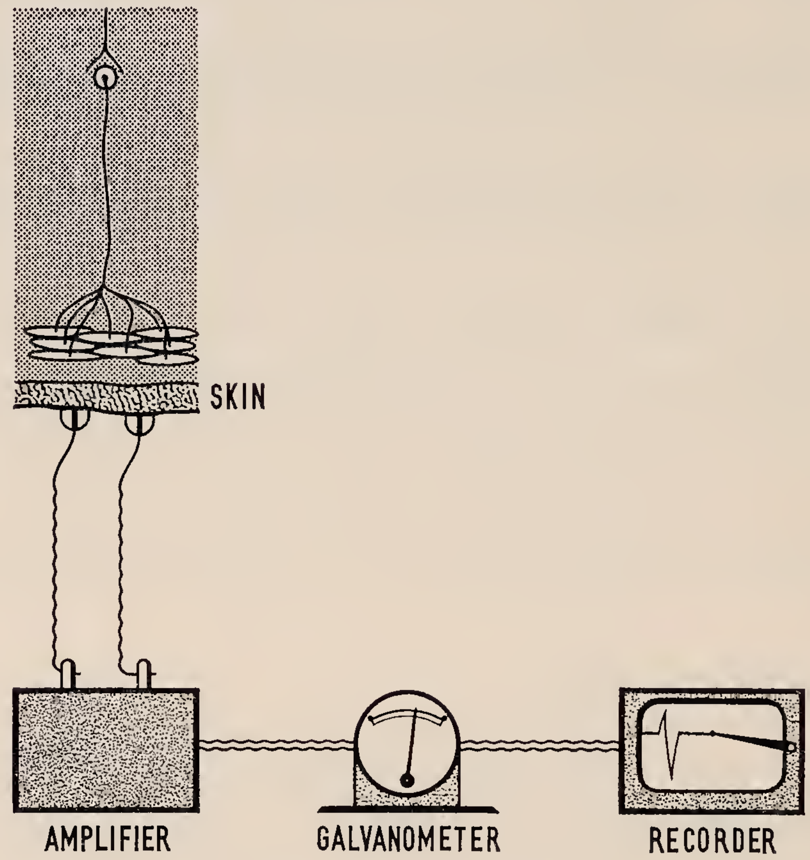

Fig. 2.—A diagrammatic representation of the method of recording the action potentials from the motor units.

electrodes were placed bilaterally over the two parts of the temporal and masseter muscles with a reference electrode placed on the midline on the back of the neck and the subject earthed (*Fig.* 1). The electromyographic patterns with the jaw in three relationships—anterior relationship, posterior relationship, and habitual relationship were recorded. The activity of the muscles in the anterior relationship of the mandible to the maxilla was recorded by asking the patient to protrude the jaw and bite in a maximum forward position. The activity of the muscles in the posterior relationship was recorded by asking the patient to retrude the jaw and bite back as far as possible. The activity of the muscles in the habitual relationship was recorded by asking the patient to close and bite in the habitual position. Each movement was observed clinically to ascertain that the patient was in the correct relationship. These three recordings enabled the muscle activity with the mandible in three different positions to be investigated.

MEASUREMENTS

The electromyographic recordings have been obtained over a period of years and two different recorders have been used, one was an ink-pen recorder and the other an ultra-violet recorder

with integrators. It was therefore necessary to make sure that both the records were comparable; this was checked by recording the same bite in a patient on the two machines. Two such records are shown in *Fig.* 3, and the percentage of the total activity for each muscle is the same within 2 per cent. It was also shown that recordings

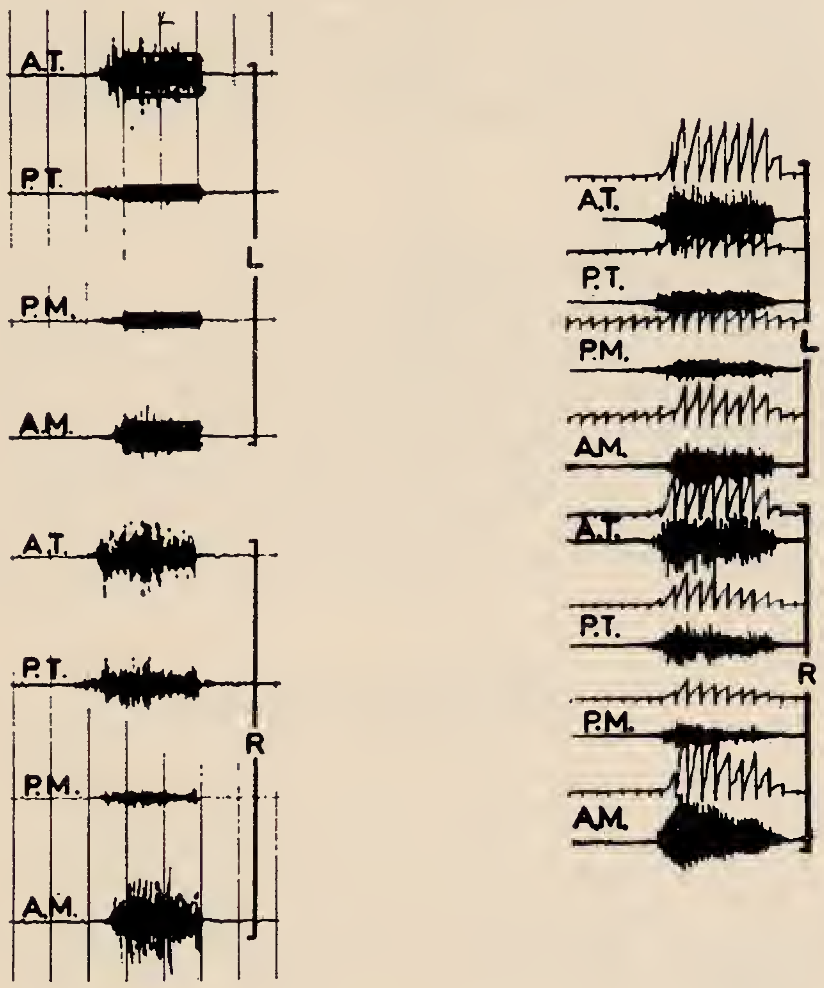

Fig. 3.—The electromyographic record on the left was obtained using an ink-pen recorder and that on the right using an ultra-violet recorder. The activities of the same movement in the same patient have been recorded. The trace above the electromyographic record on the right is the integration of the muscle activity. The lines drawn across the majority of the peaks on the ink-pen recording illustrate the method of measurement.

A.T. Anterior temporal muscle; P.T. Posterior temporal muscle; P.M. Posterior masseter muscle; A.M. Anterior masseter muscle; L. Left side; R. Right side.

from both machines for the same bite in different patients were the same at the 1 per cent level of probability.

A similar method of measurement was applied to all recordings and although the integrated traces were more accurate, these were not used as the original ink-pen recordings had no integrators. A section of the record where the muscle activity in all channels was steady, neither increasing nor decreasing, was taken and a mean line drawn through the majority of the peaks above and below the base line. The distance between the lines was measured in millimetres at the same point in time for each of the eight muscles investigated (*Fig.* 3). The maximum error in measuring 80 muscle activities 10 times was estimated at 2 per cent. Originally several records of the same bite were measured, but it was found that when the percentage of activity was calculated for each muscle, this remained fairly constant in each movement (within 4 per

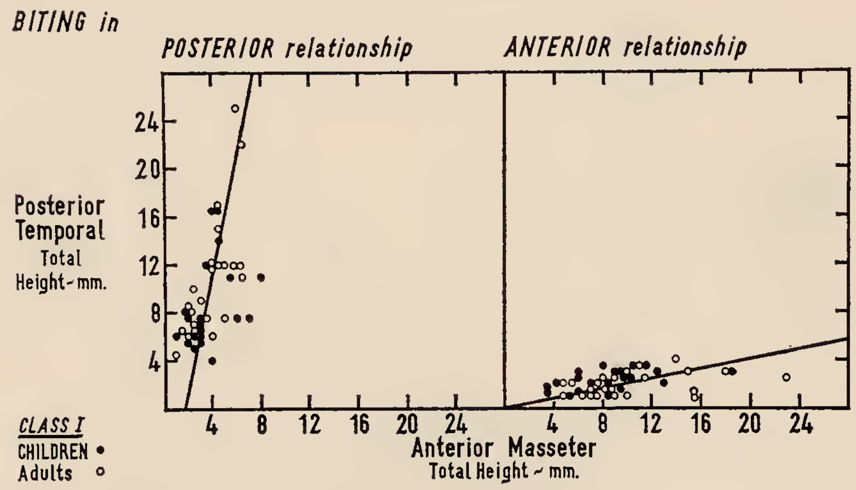

Fig. 4.—The activities of the anterior masseter and posterior temporal muscles in the anterior and posterior relationships in Class I cases are plotted against one another and the lines of best fit for the whole group are illustrated.

cent) and therefore in this investigation only one record of each relationship was measured, either the second or the third record.

RESULTS

The anteroposterior position of the mandible is controlled, in part, by the activity of the anterior masseter and the posterior temporal muscles. As a slight deviation of the jaw may have occurred in the movements recorded, the sum of the activity of the left and right posterior temporal muscles was plotted against the sum of the activity of the left and right anterior masseter muscles, in all the groups, for each of the relationships of the jaw. This gives an indication of the ratio of activity between the two muscles in the three positions.

Class I

The activity of the muscles with the jaw in an anterior relationship, in both children and adults, results in a decrease in posterior temporal muscle activity (*Fig.* 4). The correlation coefficients for both adult and child groups were significant at the 5 per cent level of probability and as the lines of best fit were almost identical the groups were combined and the line of best fit for the whole group is shown in *Fig.* 4.

In the posterior relationship both the child and adult groups showed a slight increase in the posterior temporal activity and a marked decrease in the anterior masseter activity. The correlation coefficients for both adult and child groups were significant at the 1 per cent level of probability

and as the lines of best fit were almost identical the groups were combined and the line of best fit for the whole group is shown in *Fig.* 4.

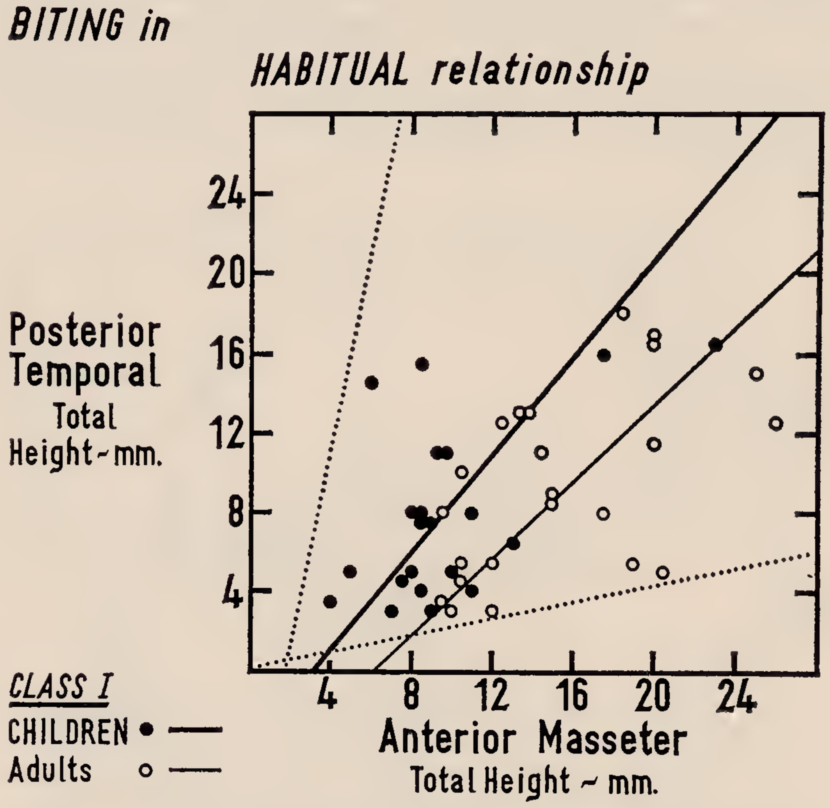

Fig. 5.—The activities of the anterior masseter and posterior temporal muscles in the habitual relationship of Class I cases are plotted against one another and the lines of best fit for the adult and child group are illustrated. The dotted lines represent the lines of best fit in the posterior and anterior relationships in Class I cases.

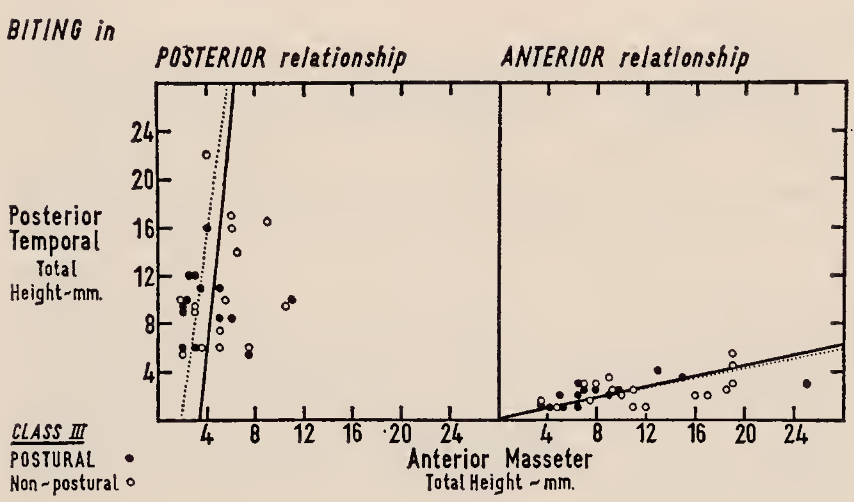

Fig. 6.—The activities of the anterior masseter and posterior temporal muscles in the anterior and posterior relationships in Class III cases are plotted against one another and the line of best fit is illustrated. The dotted line represents the line of best fit for Class I cases in these relationships.

The muscle activity in the habitual relationship was different in the two groups. In the children the activity of the posterior temporal muscle was slightly greater than that of the anterior masseter muscle, whereas in adults the pattern of activity was reversed, the activity of the anterior masseter muscle being slightly greater than that of the posterior temporal muscle. These are shown in *Fig.* 5. It will also be observed that the ratio of anterior masseter activity to posterior temporal activity in adults was almost 1:1 in habitual relationship. The correlation coefficient was significant in the adults at the 1 per cent level of probability and the children at the 5 per cent level of probability. Statistically the two groups were significantly different $0{\cdot}01 < P < 0{\cdot}05$. In children the activity of the anterior temporal, the anterior masseter, and the posterior temporal muscles are almost equal, but in the adult the activity of the anterior masseter is greatest with the anterior temporal activity slightly less and the posterior temporal activity least.

Class III

In Class III cases the patterns of muscle activity with the mandible in an anterior relationship are similar statistically to those of Class I in an anterior relationship $P > 0{\cdot}99$. In both postural and non-postural Class III cases the correlation coefficients were significant at the 1 per cent level of probability and as the lines of best fit were almost identical the groups were combined. The line of best fit is compared with Class I anterior relationship in *Fig.* 6.

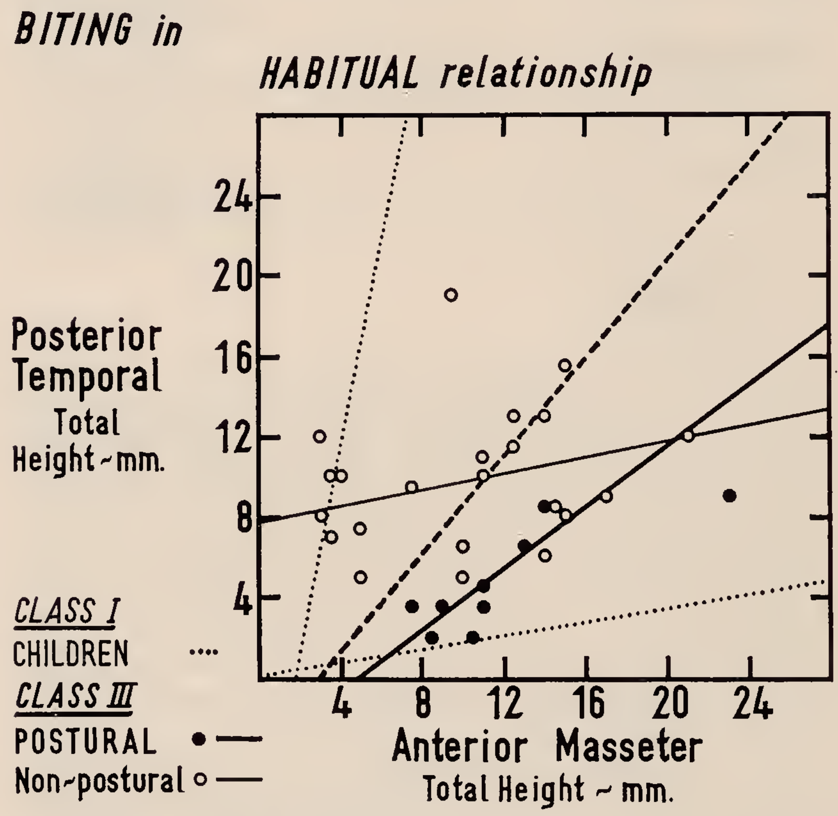

Fig. 7.—The activities of the anterior masseter and posterior temporal muscles in the habitual relationship in Class III cases are plotted against one another and the lines of best fit for the postural and non-postural groups are illustrated. The fine dotted lines represent the lines of best fit for the posterior and anterior relationship of Class III cases and the dashed line, the line of best fit for the habitual relationship in the Class I child group.

The ratio of activity of anterior masseter muscle plotted against posterior temporal muscle in the habitual relationship gave a widespread scatter but when differentiated into postural and non-postural groups it can be seen (*Fig.* 7),

that the postural group have a lower posterior temporal muscle activity, which indicates that these have an anterior relationship of the jaw. It will also be seen that some of the non-postural cases showed a decrease in the anterior masseter the ratio then changed and the posterior temporal muscle activity was greatest and the activity of the anterior masseter muscle had decreased, resulting in a definite posterior relationship of the jaw in most cases. The treatment of the Class III cases

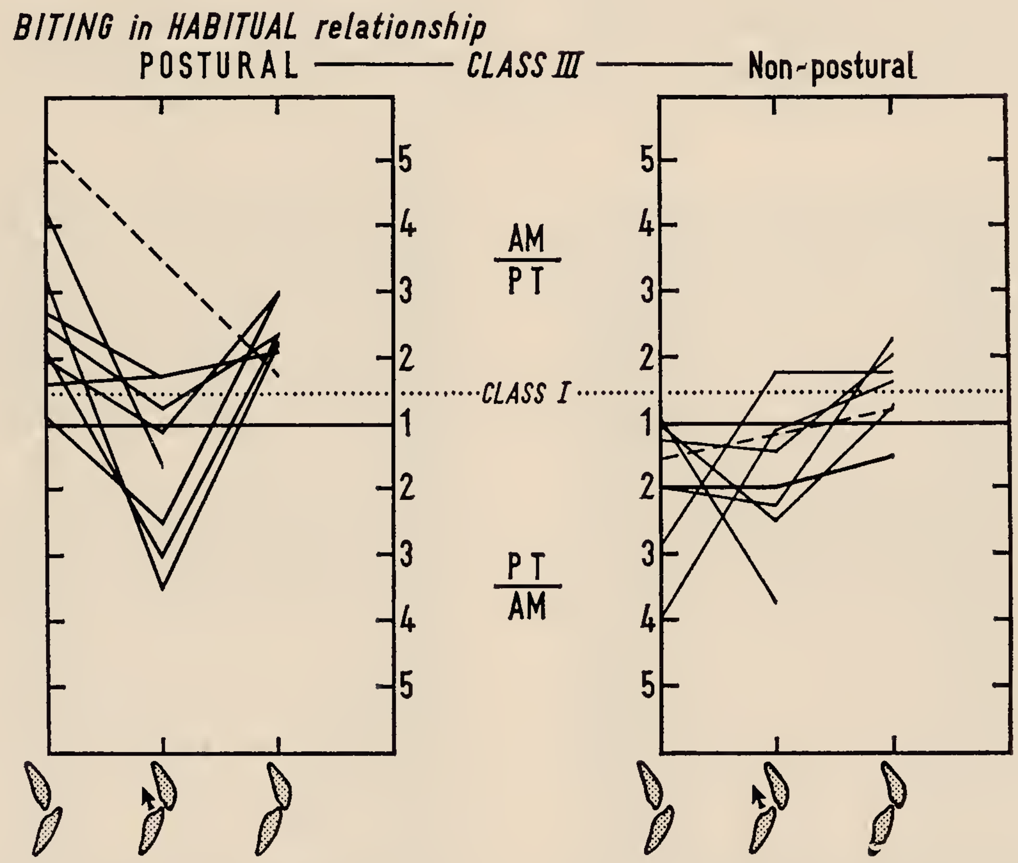

Fig. 8.—The ratio of activity of the anterior masseter muscle and the posterior temporal muscle before treatment, after a Class I relationship had been established, and out of retention is shown for postural and non-postural Class III cases. The broken line represents cases where only satisfactory records before treatment and out of retention were obtained. The thick line in the non-postural group represents one of the early Class III cases which received no further treatment when a Class I relationship had been obtained and this remained in a posterior relationship.

muscle activity. When the muscle activities of the postural Class III cases were compared with those of Class I children in the habitual relationship, they were significantly different $P > 0{\cdot}001$.

In the longitudinal survey of Class III cases, each case was recorded before treatment, after an acceptable Class I incisor relationship had been established at the end of active treatment, and then finally from one to two years out of retention. The same movements were recorded as in the previous cases. In order to demonstrate graphically the change in the activities of the anterior masseter and the posterior temporal muscles, *Fig.* 8 shows the activities expressed as a ratio obtained by dividing the greatest activity by the smallest activity, of these two muscles. The parts below the line indicate that posterior temporal activity is greatest and those above the line indicate that anterior masseter activity is greatest. On the left hand side the muscle activities of the postural Class III's have been recorded and it shows that in all cases the activity of the anterior masseter muscle is greatest and the posterior temporal muscle activity is decreased, the jaw tending to be in an anterior relationship. When a satisfactory Class I incisal relationship had been established, was then continued by proclining the upper incisors or retroclining the lower incisors. The ratio then returned to a similar level to that of Class I cases. This level was then maintained during the ensuing years out of retention. As a comparison the average ratio for Class I children is also shown in *Fig.* 8 and this did not alter over a similar period.

All the cases of non-postural Class III began with the activity of the posterior temporal muscle greater than the activity of the anterior masseter muscle. When the incisors were in a Class I relationship the ratio remained constant or increased indicating a more posterior relationship in all but two cases. In both of these cases although the central incisors were in a Class III relationship a lower lateral incisor was retroclined and in Class I incisal relationship, thus locking the bite. When the incisors were alined the jaw returned to a more anterior relationship. If further treatment was given to the Class III's the relationship returned to a level similar to that of Class I cases. Some of the original Class III cases investigated received no further treatment, showed low activity of the anterior masseter muscle, and remained in a posterior relationship.

DISCUSSION

The results indicate a difference in the muscular activity in the habitual relationship of the jaws in children and adults. In the child the activity of the anterior masseter, posterior temporal, and anterior temporal muscles is almost equal, whereas in the adult the anterior masseter muscle activity is greater than anterior temporal muscle activity, which in turn is greater than the posterior temporal muscle activity. The difference is possibly due to the transitional state of the occlusion and jaws. In the child the articular eminence is not pronounced, the jaws are growing and there is an increase in biting power. The incisor relationship may also exert more influence on the anterior posterior relationship of the jaw due to the lack of occlusion in the buccal segments during the development of the dentition.

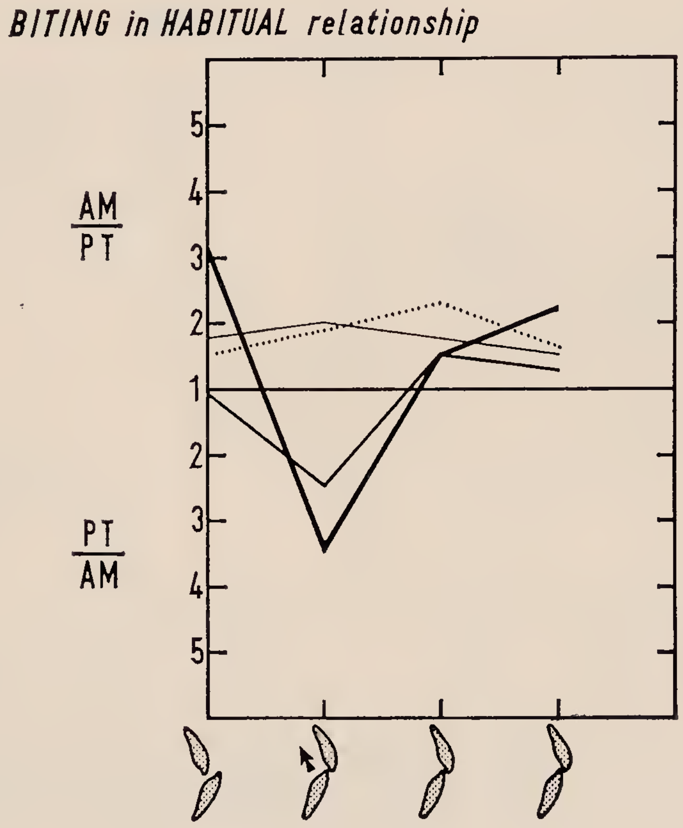

Fig. 9.—The ratio of activity of the anterior masseter muscle and the posterior temporal muscle in the habitual relationship, before treatment, when a Class I relationship had been established, out of retention, and two years out of retention, is shown. The thick line represents a treated postural Class III case, the medium line, a treated non-postural Class III case and the fine line a Class III case without treatment. The dotted line represents a Class I child whose records had been obtained over a similar period of time.

In the posterior relationship, where the muscular activity is the same for adults and children, there is a decrease in anterior masseter activity and the posterior temporal activity increases (*see Fig.* 4). The actual movement of the jaw in this relationship is small (0·5–2·0 mm.) but is accompanied by a typical electromyographic pattern. It has been well established by Thilander (1964) that the temporomandibular joint is well innervated and the recent animal experiments by Greenfield and Wyke (1966) have shown that discharges from the mechano-receptors in the joint capsule significantly contribute to the reflex co-ordination of the masticatory muscle activity, both facilitatory and inhibitory, during jaw movements.

The mandible can move up to 10–15 mm. forwards into the anterior relationship. In this position, in both children and adults, the activity of posterior temporal muscle is decreased, probably due to reflex inhibition of the muscle in this relationship.

In the anterior position and the posterior position there is an inverse relationship of the activity of posterior temporal and anterior masseter muscles and in habitual relationship the activity is nearly equal, although anterior masseter muscle activity is always slightly greater than the posterior temporal muscle activity. The relationships of the mandible to the maxilla can be clearly demonstrated by observing the electromyographic pattern.

It was also noted that when the biting force was increased in the habitual relationship the activities of both the anterior masseter and the posterior temporal muscles increased. If the direction of the anterior masseter fibres is considered it will be noted that they run at 45° downwards and backwards to the ascending ramus of the mandible, and contraction of this muscle in occlusion would tend to move the head of the condyle forwards giving pressure on the anterior aspect of the articular disk. Contraction of the posterior fibres of the temporal muscle would prevent this tendency and help to keep the condyle head in the correct relationship in the fossa.

In the anterior relationships, the muscle activity of the Class III group were similar to those of Class I, indicating that the same muscles were responsible for the position of the mandible. In the postural group, however, the posterior temporal muscle activity in the anterior relationship was only slightly less than the activity of the posterior temporal muscle in the habitual relationship, indicating that in postural Class III cases the habitual bite tended to be an anterior relationship.

The low correlation coefficient obtained when analysing the electromyographic recordings of muscle activity in the posterior relationship in Class III cases indicates the difficulty experienced in obtaining this movement. Usually it was achieved by asking the patient to attempt to bite on the incisor teeth. After the Class III cases had been treated the muscle activities in the posterior relationship and anterior relationship were similar to the muscle activities in Class I cases in the anterior and posterior relationships.

In postural Class III cases the anterior relationship of the jaw is probably due to a reflex activity to avoid an edge-to-edge contact of the incisors which, as suggested by Ballard (1955),

arises from skeletal and environmental factors which result in the development of an edge-to-edge bite. The clinical assessment of an anterior relationship was confirmed by the decrease in posterior temporal activity on the electromyographic records.

In the habitual relationship certain non-postural Class III cases have a decrease in anterior masseter activity indicating a tendency to a posterior relationship. This was accounted for in two cases by the locking of the bite due to cuspal interference; but in the remainder no such factor was found. Clinically it was also noted that in many of the Class III cases there was a tooth-apart swallow, the posterior teeth were not in contact and the incisors were almost in contact. This suggests that the habitual relationship, though efficient for mastication was not a comfortable position. The position of the jaw during swallowing would allow the tongue to spread over the teeth, which may be associated with a failure of eruption of the teeth in the buccal segments, and may also account for the tendency to a posterior relationship.

During the treatment of postural Class III cases the anterior displacement of the mandible was corrected by moving the incisors forward over the bite or by retracting the lower incisors. When the incisors were in a Class I relationship and the appliance was removed the electromyographic recording showed, by an increase in the posterior temporal muscle activity and a decrease in anterior masseter muscle activity, that the jaw was in a posterior relationship. If the patient were to be left in this position two things might happen—either the incisors might loosen or a potential temporomandibular joint dysfunction might develop. In some of the original cases investigated no further treatment was given and one of these developed temporomandibular joint pain. Our experience showed that the Class III cases did not automatically develop a normal muscle pattern and in the rest of the series the patients were treated for a further period to eliminate the posterior relationship which may have been caused by a posterior displacing activity of the jaws due to the incisal contact. This was observed clinically in some cases. Schwartz (1961) also reported that early treatment in many Class III cases resulted in a posterior displacement of the jaw, which could be observed clinically, Further treatment also established a pattern of activity in the anterior and posterior relationship similar to those seen in Class I cases.

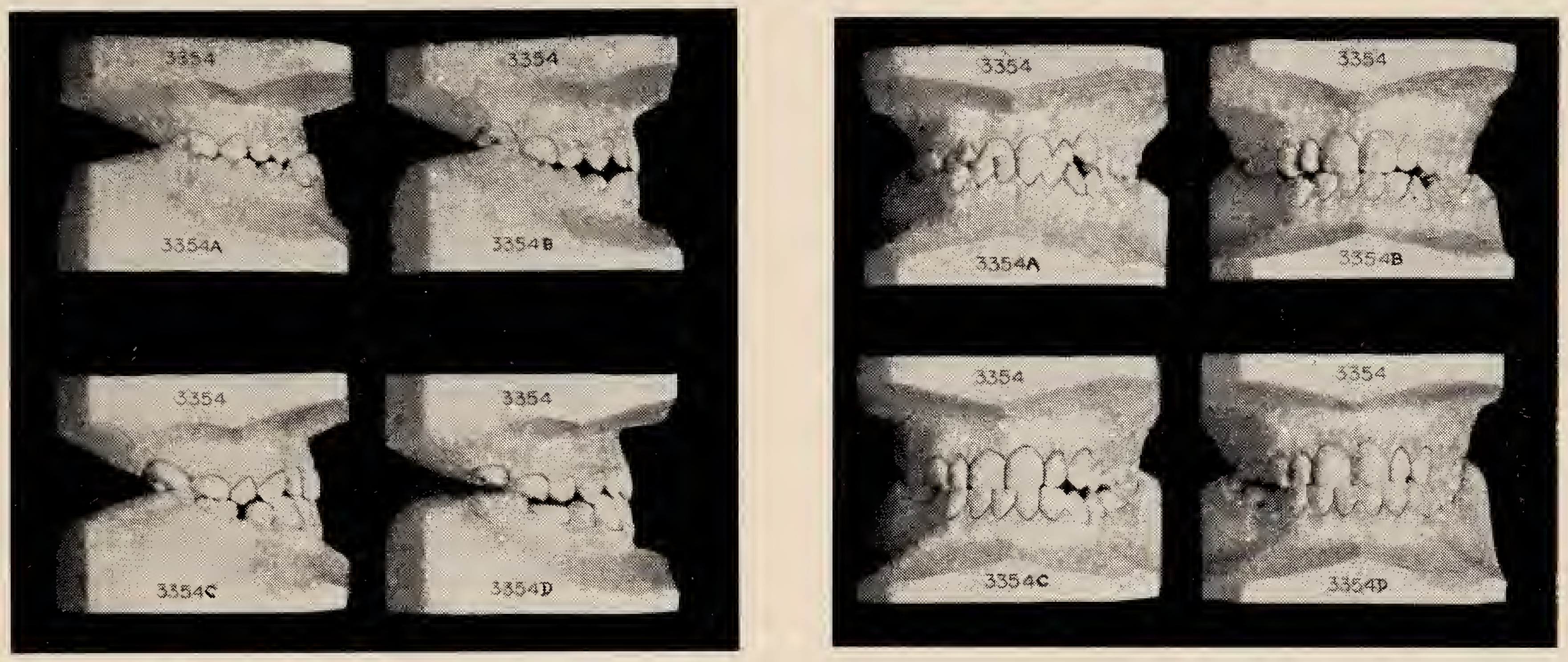

Fig. 10.—The models of a treated postural Class III case shown in *Fig.* 9. *Left*, Lateral view. *Right*, Anterior view. (A) before treatment (B) when a Class I relationship has been established (C) out of retention (D) two years out of retention.

In order to ascertain whether the patterns of activity would remain stable, a few untreated Class III cases were observed over a similar period to those under treatment and their original muscular pattern did not alter (*Fig.* 9). Similarly, an example of a Class I case is also shown and this indicates a stability of the electromyographic pattern over a long period of time. These records indicate that the changes observed in the electromyographic patterns were the result of treatment and not the result of a changing muscular pattern.

The establishment of a normal electromyographic pattern at the end of treatment and its stability following treatment 2–3 years out of retention indicates that this is satisfactory orthodontic and functional relationship. The models shown in *Fig.* 10 illustrate a treated postural Class III. During treatment when the incisors

were over the bite the patient's electromyographic records showed a typical posterior relationship (*Fig.* 9). As further proclination of the upper incisors may have resulted in an anterior open bite and a probable relapse, the $\overline{5|5}$ were extracted

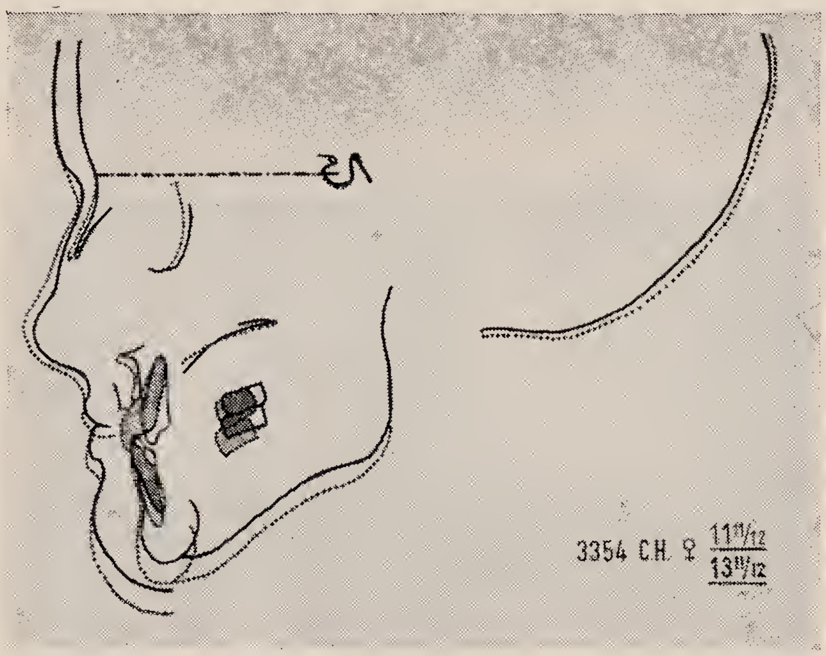

Fig. 11.—The cephalometric tracings of the postural Class III case showing the proclination of the upper incisors and the retroclination of the lower incisors during treatment.

and the $\overline{43|34}$ retracted followed by the retraction of the lower incisors. The cephalometric changes during treatment are shown in *Fig.* 11. Following this treatment a stable orthodontic and functional result was obtained and the electromyographic pattern has remained stable for two years out of retention (*Fig.* 9).

The non-postural Class III cases show a similar change in the electromyographic pattern during treatment (*Fig.* 8). All but two started with a posterior relationship which either remained or increased, when a Class I incisor relationship had been established. Further treatment eliminated the posterior relationship, and the electromyographic patterns became similar to those for untreated Class III and Class I cases

These results indicate the importance of assessing the relationship of the jaws following orthodontic treatment, as the satisfactory orthodontic result is not necessarily a perfect functional result. The relationship of the jaws can be assessed by examining the activity of the anterior masseter and posterior temporal muscles using electromyographic equipment. The activity of these muscles may be tested clinically by placing the fingers on the anterior masseter muscle and thumbs on the posterior temporal muscle and feeling for the contraction of the muscles in the habitual relationship (*Fig.* 12). As both muscles are superficial the contraction can be felt and the timing and amount of contraction should be noted. If the anterior masseter muscles do not contract and feel ' flat ' and there is contraction of the posterior temporal muscles, the jaw is in a posterior relationship. An anterior relationship produces anterior masseter muscle contraction with very little posterior temporal muscle contraction. This is only a rough guide but is a clinical method of assessing the relationship of the jaw

Fig. 12.—The position of the fingers and thumb when palpating for the activity of the anterior masseter and the posterior temporal muscles is illustrated.

before and after treatment. The posterior displacement which occurs in some Class II, division 2 cases can also be detected by using a similar method.

SUMMARY

The electromyographic patterns of 40 Class I cases and 32 Class III cases have been investigated and the activity of the anterior masseter muscle and the posterior temporal muscle have been shown to be important in determining the anteroposterior relationship of the jaws.

A longitudinal study during treatment has shown that following treatment, when the incisors are in a Class I relationship, the jaw may be in a posterior relationship, and further treatment is necessary to eliminate this displacement and possible loosening of the incisor teeth.

A clinical method for assessing muscle activity is described.

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REFERENCES

BALLARD, C. F. (1955), *C. R. Soc. franç. Orthop.*, **26,** 451.

BLYTH, P. (1958), *Trans. Brit. Soc. Orthodont.*, 89.

CAMPBELL, J. (1954), *Ibid.*, 84.

CARLSOO, S. (1958), *Int. dent. J., Lond.*, **8,** 166.

GREENFIELD, B. E., and WYKE, B. D. (1955), *J. Anat., Lond.*, **89,** 578.

— — — — (1956), *Brit. dent. J.*, **100,** 129.

— — — — (1966), *Nature* (in press).

PERRY, H. T., and HARRIS, S. C. (1964), *J. Amer. dent. Ass.*, **48,** 663.

SCHWARTZ, A. M. (1961), *Lehrgang der gebissregelung;* Innsbruck: Verlag Urban & Schwarzenberg.

SICHER, H. (1965), *Oral Anatomy*, St. Louis: Mosby.

THILANDER, B. (1964), *Acta odont. scand.*, **22,** 51.

TULLEY, W. J. (1953), *Trans. Brit. Soc. Orthodont.*, 88.

DISCUSSION

Dr. W. Grossman, opening the discussion, said that Greenfield and Wyke had assessed systematically the activities of the temporal and masseter muscles during different mandibular movements and were able to show that electromyography allowed accurate diagnosis of any postural abnormality in the maxillo-mandibular relationship. While the clinical diagnosis of the true mandibular protrusion was easy, the accurate assessment of the borderline cases showing symptoms of both true and postural Class III might be very difficult.

Moss and Greenfield had been able to throw some light on to this subject. It would have been interesting to have some observations on the path of closure in Class II, division 2 cases. Recently it had been stated that the Class II, division 2 type of malocclusion and certain postural Class III cases had many common features.

It would have been a great advantage if they had been able to hear something about correlating electromyographic findings with cephalometric results. He asked Mr. Moss whether he had considered this. He asked also whether Mr. Moss's X-ray examinations of the temporomandibular joint had shown changes in condylar position as this would be expected from the electromyographic findings.

Professor Tulley said he was a little worried about the sub-divisions of Class III malocclusions, which were used in this paper, but Mr. Moss had made reservations on this point. He said he thought there was no true dividing line between postural Class III and true skeletal Class III.

With regard to the different electromyographic findings in children and adults with normal occlusion, this could certainly be explained by the changing anatomical configuration of the musculature.

Interpretation of any electromyographic findings is open to criticism. Dr. Sicher once said: ' All the electromyogram shows is that a muscle is contracting. It does not tell you what it is doing. '

Had the authors investigated the so-called postural Class III as it developed at the time of eruption of the lower permanent incisors in cases where there was a virtually Class I dental base relationship? This would make an interesting longitudinal study, and it should be possible to observe the change in the muscle activity in the biting position before and after treatment.

He did not think there was any reason why the incisors should be unduly stressed if they were moved over the bite and allowed to move into final position by the occlusal forces. He thought that Mr. Moss took rather a pessimistic view of leaving some mild Class III cases with the incisors not fully proclined by the appliances. It was only where the skeletal discrepancy was very adverse that upper incisors could be proclined to a position where they were in danger of receiving undue stress.

Mr. J. P. Moss thanked Dr. Grossman for his comments. He and Mr. Greenfield were looking at Class II, division 2 cases but at the moment it was rather early to say very much about them. They had assessed the Class III cases cephalometrically and most of them were usually mild skeletal Class III's or definite skeletal Class III's. Very few of the cases of postural Class III's were in actual fact on a skeletal Class I base. They also noted that the maxillo-mandibular plane angle even during treatment, except in four cases, hardly altered at all.

As far as the condylar position was concerned, he had prepared a slide of one of the Class III cases with the mandible biting in a composition bite in the normal relationship, in an anterior relationship, and a posterior relationship. The relationship of the condyle in the fossa was shown in the slide. The electromyographic recordings were then taken with the composition bites in the mouth. There was very little movement of the condyle. In the retrusive bite it was downwards and backwards and in this position if one considered the action of the posterior temporal muscle, what happened was that, because it was coming over the zygomatic arch, it tended to pull the coronoid process upwards and backwards and tilt the head of the condyle downwards and backwards.

He thanked Professor Tulley for his comments. He was sorry Professor Tulley was not absolutely convinced about the activity of the muscles and he agreed that the habitual bites were the most interesting bites in these Class III cases. As far as the muscle activity in the so-called postural Class III cases was concerned, the only ones that they had looked at, at a very early age, were skeletal ones and not postural, so he could not say anything about the changes that occurred in one of these postural cases.

Dr. J. R. E. Mills asked Mr. Moss how he defined Class III malocclusions for the purpose of the investigation. Secondly, how did Mr. Moss decide whether a case was what he called postural or non-postural?

Mr. Moss said that for this particular investigation they considered that a Class III occlusion was that in

which there was a reverse overbite and a reverse overjet. Obviously in some of the Class III cases the reverse overbite was very small and in the majority of the cases they went on the molar relationship as well. Obviously they had to correct for other factors such as early loss of deciduous teeth which altered the molar relationship. The reverse overbite was often an incomplete one and some of the cases had an anterior open bite and therefore, the main thing was the reverse overjet. This was a clinical investigation and the cases were observed in what he determined to be the rest position and then one watched the position of the incisors during closure to determine the path of closure.

Mr. J. C. Ritchie asked what the ages of the children were in this study, particularly because Mr. Moss mentioned the fact of looking at younger children as well.

Mr. Harold Chapman had once told him that he had found only one case in which there was a prenormal occlusion prior to 18 months of age. In the course of his own work he had looked at the mouths of many thousands of small children before the age of 18 months and he had never found one case that was prenormal. It appeared that in some cases, when the temporary lower canines were late in erupting, and the upper teeth were fully erupted then the cusps of the lower canines came into an edge-to-edge bite with the uppers. This created a bite of two-point contact and the mandible then tended to move forward or to the left or to the right, and it was entirely a matter of chance as to which way it did move.

Mr. Moss replied that the ages ranged from about 4 to 16 and they did not have any of the very young children at all. The problem with the younger child was that it was very difficult to get them to understand what one wanted them to do during the investigation.

Mr. B. C. Leighton said in his experience of examining something like 600–700 children under the age of 18 months, he had found at least 4 who had a prenormal relationship of the incisor teeth at the time they erupted.

Mr. N. Upson asked Mr. Moss about the actual technique he applied to the movement of the teeth. Were the upper incisors proclined, or were lower premolars removed and the lower incisors retracted? Would there be any change electromyographically in these two types of cases?

Mr. Moss replied that these Class III cases were treated by a variety of methods with extractions in cases where there was considered to be crowding. Several of them were treated by moving the upper incisors forward provided the amount of overbite would allow this to be done and if not, they extracted in the lower arch and retracted the lower incisors back. Some cases were treated by the Andresen appliance and satisfactory results were obtained. It did not seem to matter which method was used, one seemed to get exactly the same electromyographic pattern.

Mr. D. J. Timms asked at what stage of the orthodontic treatment were some of these readings taken? He particularly wanted to know in the postural Class III case when the intermediate electromyograph was taken. When one moved the upper incisors forward in the postural Class III, there was a period where the incisors only were in contact; the posterior teeth were out of contact. He had the impression that that happened in one or two of the study models shown on the slide. If the electromyograph was taken at that point of treatment, one could expect nothing else but a very large posterior temporal reading, in which case it would rather exaggerate the difference between the two graphs showing the difference in the types of Class III cases.

Mr. Moss replied that in all these cases the molars were together.

Mr. Emery asked Mr. Moss if he found in his investigation any difference in muscle activity between those non-postural Class III cases with the high Frankfort-mandibular-plane angle and those with the low angle.

Mr. Moss said that he did not look at this particular point but going down his results many of those that had a postural relationship had a slightly higher Frankfort-mandibular-plane angle than the non-postural cases. The highest recorded was 38°.

Mr. R. Marx said that one could claim that the electromyograph enabled one to see which muscles were contracting isometrically. This necessarily meant that to give isometric contraction, one usually had to get occlusal contacts. He therefore asked Mr. Moss whether he made any note of where his occlusal contacts were, not only in the habitual but in the postural positions recorded.

Mr. Moss said that it was difficult to record, in a retrusive bite especially, whether a patient's teeth were actually together; but when they did these recordings, they looked and saw that there was occlusal contact between the teeth before making the record.

Mr. Greenfield said that one could get isometric contraction without true contact. It only meant that the two ends of the muscle were not moving. One could still have isometric contraction with the teeth apart.

Mr. Marx said that he did not claim that one could only get isometric contraction when there was contact. So far as the masseter muscle and certainly as far as the anterior masseter was concerned, it certainly always meant one had to have incisor contact.

REPORTS OF MEETINGS

ORDINARY MEETING, 11 January

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 11 January, 1965, at 7.30 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Apologies for Absence

Apologies for absence were received from Mr. M. A. Kettle, Mr. D. Logie, Mr. D. G. Timms, Mr. J. H. Gardiner, Mrs. V. K. Stanley, and Professor R. X. O'Meyer.

Minutes

The Minutes of the December Ordinary Meeting were read and confirmed and signed by the President.

Candidates for Election

The following candidates for membership were elected unanimously:—

Ordinary Membership

Mr. B. J. Gerraty, B.D.Sc. (Melb.), L.D.S. (Vic.), D.Orth. R.C.S.(Eng.), 13, Amersham Hill, High Wycombe, Bucks.

Mr. B. D. Smith, L.D.S. R.C.S.(Eng.), 22, Ulster Place, Upper Harley Street, London, N.W.1.

Mr. R. J. Thomas, B.D.S.(U.Lond.), F.D.S., D.Orth. R.C.S.(Eng.), Fairbourne, Furze Hill, Runfold, Nr. Farnham, Surrey.

Mr. N. Upson, L.D.S.(U.L'pool), D.Orth. R.C.S.(Eng.), 21, Hollingsworth Court, Lovelace Gardens, Surbiton, Surrey.

Miss J. N. Wood, B.D.S.(Glasgow), Orthodontic Department, Turner Dental School, Bridgeford Street, Manchester 15, Lancashire.

Mrs. K. W. L. Wraith, B.D.S.(U. St. Andrews), D.Orth. R.C.S.(Eng.), 1, Jameson Lodge, Shepherd's Hill, Highgate, London, N.6.

Mr. G. Wreakes, B.Ch.D., L.D.S.(Leeds), F.D.S., D.Orth. R.C.S.(Eng.), 7 Appledore Crescent, Main Road, Sidcup, Kent.

Corresponding Membership

Mr. T. C. Choo, B.D.S.(Malaya), F.D.S., D.Orth. R.C.S.(Eng.), F.D.S. R.C.S.(Edin.), Suite E1, 5th Floor, Macdonald House, Orchard Road, Singapore 9, Malaysia.

Dr. M. Schouker-Jolly, D.F.M.P., D.E.O.P., 1, Rue Bannier, Orleans, France.

After welcoming visitors and inviting them to consider themselves members for the evening, The President delivered his Presidential Address entitled, '*There's a Divinity that Shapes Our Ends, ...*'

A vote of thanks was proposed by Mr. T. D. Foster, seconded by Mr. C. P. Briggs, and carried with acclamation.

ORDINARY MEETING, 8 February

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 8 February, 1965, at 7.30 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Minutes

The Secretary (Mr. Alan C. Campbell) read the Minutes of the Ordinary Meeting held on Monday, 11 January, 1965, and these were confirmed and signed as a correct record.

Apologies for Absence

Apologies for absence were received from Mr. D. A. Dixon, Dr. J. R. E. Mills, and Mr. M. A. Kettle.

Introduction of Members

The following members whose election had been confirmed at a previous meeting, were introduced: Mr. B. D. Smith, Mrs. K. W. L. Wraith, and Mr. R. J. Thomas.

Candidates for Election

The following candidates for Ordinary Membership were elected:—

Miss J. M. Dumbrell, L.D.S. R.C.S.(Eng.), Greenlands, Sheringham, Norfolk.

Mr. E. D. Fulstow, B.D.S.(Lond.), F.D.S., D.Orth. R.C.S.(Eng.), 87, Love Lane, Pinner, Middlesex.

Mr. E. A. Glover, B.D.S.(Lond.), Rectory House, 40, Epsom Road, Guildford, Surrey.

Mr. G. S. Hobson, B.D.S.(Q.U.Belf.), 10, Elmwood Avenue, Belfast, Northern Ireland.

Miss M. R. Kerr, B.D.S.(Birm.), D.Orth. R.C.S.(Eng.), 20, Brook End Drive, Henley-in-Arden, Solihull, Warwickshire.

Miss J. J. Maguire, B.D.S.(Lond.), Edgefield, Cranleigh, Surrey.

Mr. J. P. Trend, B.D.S.(Lond.), 22, Green Dragon Lane, London, N.21.

The Chairman welcomed any visitors who might be present.

He then introduced Mr. B. S. Cryer, who read his Short Communication entitled, '*The Unpredictable Lower Second Premolar?*'.

He then asked Mr. G. H. Steel to read The Chapman Prize Essay for 1964, entitled, '*The Relation between Dental Maturation and Physiological Maturity*'.

Following the reading of the Essay, the President presented the Chapman Prize to Mr. Steel.

ORDINARY MEETING, 8 March

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 8 March, 1965, at 7.30 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Apology for Absence

The Secretary reported that an apology for absence had been received from Mr. J. D. Maclure.

Minutes

The Minutes of the meeting held on Monday, 8 February, 1965, were read by the Secretary, confirmed, and signed as a correct record.

Introduction of Members

The following members whose election had been confirmed at a previous meeting were introduced: Mr. A. J. Wilson, Mr. E. A. Glover, Miss J. M. Dumbrell, Mr. N. Upson, Mr. B. J. Gerraty, and Mr. E. D. Fulstow.

Candidates for Election

The following candidates for Ordinary Membership were elected:—

Mr. A. C. L. Gibson B.D.S.(U.Glas.), 211, Renfrew Street, Glasgow, C.3.

Mr. D. Seel, B.D.S.(U.Manc.), F.D.S., D.Orth. R.C.S.(Eng.), The Dental Hospital, Lower Maudlin Street, Bristol 1.

The President welcomed any visitors who might be present and he introduced Mr. E. J. S. Clifford, from Liverpool, who presented his paper entitled '*The Watkin Free-sliding Arch—an Introduction*', following which Messrs. A. J. P. Cousins and W. J. Clark read a paper on '*Extra-oral Traction*'.

RESEARCH MEETING, 29 April

The Research Meeting of the Society was held at Birmingham Dental Hospital, St. Mary's Row, Birmingham 4, on Thursday, 29 April, 1965, at 2.00 p.m. The President, Mr. A. J. Walpole Day, occupied the Chair, and research reports and papers were presented as follows:—

Papers

Mr. A. Richardson: '*The Pattern of Alveolar Bone Resorption following Extraction of Anterior Teeth*'.

Mrs. M. E. Richardson: '*The Relationship between the Relative Amount of Space present in the Deciduous Dental Arch and the Rate and Degree of Space Closure subsequent to the Extraction of a Deciduous Molar*'.

Research Reports

Mr. D. A. Dixon and Mr. J. R. Pettman: '*Some Applications of Ultrasound in the Examination of Oral and Facial Tissues*'.

Mr. D. T. Bennett and Mr. F. Smales: '*The Development and Clinical Application of a New Technique for Measuring Changes in the Angulation of the Incisor Teeth following Appliance Therapy*'.

Mr. P. Vig: '*An Investigation into the Physical and Physiological Aspects of Speech*'.

Mr. J. F. Gravely: '*Third Molar Development*'.

Dr. J. R. E. Mills: '*Dental Occlusion in the Earliest Mammals*'.

COUNTRY MEETING, 30 April

The Country Meeting of the Society was held in the Medical School, University of Birmingham, Edgbaston, on Friday, 30 April, 1965 and in Birmingham Dental Hospital on Saturday, 1 May, 1965.

The Vice-Chancellor of the University of Birmingham, Sir Robert Aitkin, D.Phil., M.D., welcomed members of the Society to the University.

The President, Mr. A. J. Walpole Day, thanked the Vice-Chancellor for his address after which The Secretary (Mr. Alan C. Campbell) read the Minutes of the previous meeting, which were confirmed and signed as a correct record.

Apologies for Absence

Apologies for absence were received from Professor O'Meyer, Mr. A. G. Taylor, Professor Tulley, Mr. G. H. Roberts, Mr. E. S. Broadway, Mr. J. R. Pettman, Mr. H. E. Wilson, Mr. S. Granger McCallin, and Mr. D. J. Timms.

Candidate for Election

Mr. A. S. Yip, Flat D., 8, Cleve Road, London, N.W.6. was elected to Ordinary Membership of the Society.

President's Introduction

The President welcomed visitors to the Country Meeting.

The Programme of the Meeting was then presented as follows:—

9.15 a.m. Opening of the Meeting by Sir Robert Aitkin, D.Phil, M.D., Vice-Chancellor of the University of Birmingham.

9.45 a.m. Symposium: Mr. J. S. Beresford, Dr. P. H. Démogé, and Mr. C. D. Parker: '*Multiband Appliances*'.

10.45 a.m. Coffee in the Museum.

11.00 a.m. Discussion on the Symposium.

12.00 noon. Short Communication: Mr. H. L. Leech: '*Simpler Cervical Traction*'.

12.30 p.m. Lunch in the Refectory.

2.00 p.m. Chairman: Mr. R. E. Rix. Paper: Mr. D. F. Glass: '*Unilateral Craniofacial Deformities*'.

3.00 p.m. Short Paper: Dr. B. Neumann: '*Common Sense in Orthodontics*'.

3.30 p.m. Tea in the Museum.

3.45 p.m. Short Communication: Mr. M. L. Brenchley: '*Borderline Class III Cases*'.

4.00 p.m. Paper: Mr. T. D. Foster: '*Uncommon Manifestation of Cleft Lip and Palate*'.

7.15 p.m. University Reception at the University Staff House, Edgbaston.

8.00 p.m. Annual Society Dinner at the University Staff House.

A Demonstration meeting was held in the Birmingham Dental Hospital on Saturday, 1 May, 1965, at 9.30 a.m.

ORDINARY MEETING, 11 October

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 11 October, 1965, at 7.30 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Obituary

The President said the meeting must begin on a sad note, as he had to announce the deaths of Mr. Harold Chapman, Mr. Warwick James, and Mr. G. J. Harborow.

Mr. Harold Chapman had been a Founder Member and an Honorary Member of the Society, one of the two Members who had held the rare distinction of having been President on two occasions, in 1925 and in 1952. A Memorial Service would be held in the Grosvenor Chapel, South Audley Street, on Friday, 29 October, 1965, at noon.

Mr. Warwick James had also been a Founder Member and an Honorary Member of the Society, and had worked in rather a broader field of dental surgery. A Memorial Service would be held at the Middlesex Hospital on 11 November, 1965, at 12.15 p.m.

The meeting stood for a few moments in respect to their memory.

Minutes

The Minutes of the Country Meeting held in Birmingham on Friday and Saturday, 30 April and 1 May, 1965, were read by the Secretary, confirmed, and signed as a correct record.

Apologies for Absence

The Secretary reported that apologies for absence had been received from Messrs. Dixon, Russell, Roper, Softley, and Watson.

Candidates for Election

The following candidates were elected to Ordinary Membership:—

Miss B. J. Baldwin, B.D.S., L.D.S.(U.Manc.), 62A, Cheam Road, Sutton, Surrey.

Mr. W. J. McK. Barrie, B.D.S.(U.Birm.), 2/4, East Hemming Street, Letham, Angus.

Mr. J. K. Chmielewski, D.E.C.D.S.(Paris), 165, Pitshanger Lane, London, W.5.

Mr. E. M. Harkness, B.D.S.(N.Z.), c/o Bank of New Zealand, 1, Queen Victoria Street, Mansion House, London, E.C.4.

Mr. J. Nicolls, L.D.S. R.C.S.(Eng.), 233, Selhurst Road, South Norwood, London, S.E.25.

Mr. R. A. Standing, B.D.S.(U.Birm.), L.D.S. R.C.S.(Eng.), 24, Bore Street, Lichfield, Staffordshire.

Mr. C. R. D. Wenck, B.D.Sc.(U.Q'land), D.Orth. R.C.S.(Eng.), 9, Fairmead Close, Heston, Hounslow, Middlesex.

The President welcomed any visitors who might be present.

The President introduced Mr. F. Allan, who presented a short communication entitled, '*A Case of Adverse Muscle Behaviour*'.

He then introduced Mr. R. H. Birch, who presented a paper by Mr. R. H. Birch and Mr. D. G. Huggins, entitled, '*A Cephalometric Investigation of Changes in Lip Separation following Retraction of Upper Incisors*'.

ORDINARY MEETING, 8 November

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1. on Monday, 8 November, 1965, at 7.30 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Apologies for Absence

Apologies for absence were received from Dr. Russell Logan, Mr. J. D. McEwen, and Mr. J. D. Robertson-Ritchie.

Minutes

The Minutes of the meeting held on 11 October, 1965, were taken as read, confirmed, and signed by the President.

Introduction of Members

The following members who had been elected since the last meeting were introduced: Mrs. H. E. Brearley and Mr. J. Nicolls.

Candidates for Election

The following members were elected *en bloc* by show of hands:—

Ordinary Membership

Mr. R. G. Bird, L.D.S. R.C.S.(Eng.), St. Mary's Croft, Chapel Field North, Norwich.

Mr. J. T. Boa, B.D.S.(U.Sydney), F.D.S., D.Orth. R.C.S.(Eng.), 74, Wordsworth Drive, North Cheam, Surrey.

Mr. D. D. DiBiase, B.D.S.(U.Lond.), F.D.S., D.Orth. R.C.S.(Eng.), 46, Childsbridge Lane, Kemsing, Kent.

Mr. B. J. Emery, B.D.S.(U.Birm.), D.Orth. R.C.S.(Eng.), 91A, Bartholomew Road, London, N.W.5.

Mr. J. H. Whitworth, B.D.S.(U.Lond.), L.D.S. R.C.S.(Eng.), Four Winds, Dalehouse Lane, Kenilworth, Warwickshire.

Mr. R. A. Wilson, B.D.S.(U.Lond.), L.D.S., D.Orth. R.C.S.(Eng.), Cranham, 90, Huggetts Lane, Willingdon, Eastbourne, Sussex.

Mr. A. R. H. Woods, L.D.S. R.C.S.(Edin.), 41, Raith Drive, Kirkcaldy, Fifeshire.

Corresponding Membership

Mr. A. C. Aamodt, L.D.S.(U.Sheff.), Cand. Odont.(U.Oslo), D.Orth. R.C.S.(Eng.), N.Eikervei 35, Drammen, Norway.

Mr. Franco Magni, Med-Chirurgo (U.Genoa), Spec. in Odontiatria (U.V.Genoa), via Cesarea 5/12A, Genoa, Italy.

Dr. G. K. Tsaltas, D.D.S.(Athens), D.Orth. R.C.S.(Eng.), 80, Laskaridou Street, Kallithea, Athens, Greece.

The PRESIDENT welcomed visitors, especially members of the British Association of Plastic Surgeons, and introduced Dr. Bengt Johanson, who delivered the nineteenth Northcroft Memorial Lecture, entitled, '*Bone Grafting and Dental Orthopaedics in Cleft Lip and Palate Surgery*'.

The PRESIDENT thanked Dr. Johanson for his Northcroft Lecture and presented him with a scroll.

ANNUAL GENERAL MEETING, 13 December

THE ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1. on Monday 13 December, 1965, at 7 p.m., with the President, Mr. A. J. Walpole Day, in the Chair.

Apologies for Absence

Apologies for absence were received from Dr. Russell Logan, Mr. Briggs, Mr. Dixon, Mr. and Mrs. Robertson-Ritchie, Professor O'Meyer, Mr. Robertson, and Professor Hallett.

Minutes

The minutes of the Annual General Meeting held on 14 December, 1964, were confirmed and signed by the President.

Election of Officers and Councillors

The PRESIDENT said that as there had been no nominations from members, the Council had made the nominations set out in the Agenda, and he declared the following duly elected:—

President:	Mr. R. E. Rix
Immediate Past President:	Mr. A. J. Walpole Day
President Elect:	Mr. J. D. Hooper
Senior Vice-President:	Mr. J. W. Softley
Vice-President:	Mr. J. S. Beresford
Councillors:	Dr. W. Grossmann
	Mr. M. A. Kettle
	Mr. J. D. McEwen
	Mr. W. A. Nicol
	Mr. N. R. E. Robertson
Treasurer:	Mr. J. S. Rose
Secretary:	Mr. A. C. Campbell
Assistant Secretary:	Mr. C. P. Briggs
Editor:	Dr. J. R. E. Mills
Curator:	Mr. B. C. Leighton
Librarian:	Miss J. C. Ritchie

On the proposition of Mr. W. A. B. Brown, seconded by Mr. D. I. Smith, Mr. P. H. Burke and Mr. J. F. Pilbeam were re-elected as Honorary Auditors. The President thanked them for their help in the past year.

Treasurer's Report

The TREASURER (Mr. J. S. ROSE) reported that the expenditure of the Society during the year had exceeded its income by £66 19s. 0d. This, he said, was almost entirely due to the increase in printing and stationery costs. Some of it was accounted for by increased prices in general for all printing, and some by increasing the Society's stocks. One individual item was the reprinting of the Constitution of the Society.

A further non-recurring item of expenditure was the purchase of a dictating machine.

In view of the increased printing costs, an additional sum had been reserved in the Balance Sheet for the Society's TRANSACTIONS.

The Society's investment in the Hertfordshire County Council Stock matured in December, and the Council was taking this opportunity to review the Society's investments.

He pointed out that the investment income of the Society was subsidizing the subscription of members. If this income should fall, and if expenses continued to rise, it might become necessary to review the subscription rate. He appealed to members to subscribe to the *Dental Practitioner* as the Society had an arrangement with the publishers in relation to their accounts and printing costs.

Once again he expressed appreciation to the Librarian for his great help with the sale of TRANSACTIONS, and he thanked the Honorary Auditors for their courtesy and helpful suggestions.

He moved the reception of his report.

On the motion of the President, the report was adopted.

Secretary's Report

The SECRETARY (Mr. A. C. CAMPBELL) reported that the past year had been an active one in which the average attendance at meetings so far

was 113, with 146 members and guests at the Country Meeting in Birmingham.

During the year the Society had the misfortune to lose their last two Founder Members—Mr. Harold Chapman and Mr. W. Warwick James, and also another Honorary Member, Mr. H. G. Watkin. In all the numbers had diminished by 17, including resignations, but there had been 36 new members, 5 of whom were corresponding members, giving a net gain during the year of 19.

The Society was now on the threshold of a new programme year, and this would be the last Annual General Meeting to be held in December. The next one would take place in Eastbourne during the course of the Country Meeting.

He moved the reception of his report.

On the motion of the President, the report was adopted.

Editor's Report

The Editor (Dr. J. R. E. Mills) said that the Society's Transactions had continued to be published in the *Dental Practitioner*. The bound Transactions for 1964 should now be in the hands of all members. The ' Notes to Readers of Papers ' had been revised during the year, and the Editor would be pleased to supply a copy to any member requiring one. Authors were reminded that they were responsible for communicating their papers to the Editor in a form suitable for publication, although the Editor was always willing to advise at any stage.

The change in the Society's year would become effective in 1966, and the Editorial Committee was already considering the programme for next winter. The Secretary would be pleased to receive offers of communications from members.

He moved the reception of his report.

On the motion of the President, the report was adopted.

Curator's Report

The Curator (Mr. B. C. Leighton) said that he was glad to be able to report the gift of two items to the Museum. Mr. C. J. Bell, of Cork, had presented study models and radiographs of a case showing supplemental upper deciduous canines. Professor Sheldon Friel had presented a large number of study models, among which were many examples of normal occlusion. Several of these had been analysed and described in a paper to the Fifth Congress of the European Orthodontic Society in 1912 by Dr. P. J. J. Coebergh. They were, therefore, of historical interest as well as academic importance. It was proposed to prepare some of this material for display at the Country Meeting in Eastbourne.

As in previous years he wished to remind members that the Museum might be visited at 28, Portland Place. He would be pleased to show both the Museum and its catalogue to any member who wished to see them. At the same time, additions to the Museum would always be most welcome. The collections of serial study models and of historically interesting appliances could both be augmented.

He moved the reception of his report.

On the motion of the President, the report was adopted.

Librarian's Report

The Librarian (Mr. D. I. Smith) said that the Library contained books, periodicals, and Transactions which were available on loan to members. Copies of the Transactions were distributed to libraries and non-members throughout the world.

The library was housed next door to Manson House in the Institute of Public Health, where space was very limited. He hoped, at some future time, the Society would be able to provide more suitable accommodation so that the Library could offer a better service.

He was handing over his duties as Librarian, and the Library would be in the capable hands of Miss J. Ritchie.

He moved the reception of his report.

On the motion of the President, the report was adopted.

The Time of Meetings

The Secretary gave the results of the questionnaire which had been circulated to members to find their views on the best time to hold the Society's meetings. Of 497 members only 136 had replied. Of these, 78 favoured a change in the time, of whom 38 had suggested a time between 6 and 7 p.m., 23 a time substantially earlier, and 17 either later or on another day. Most of those who were opposed to change lived in the London area.

The President then announced that while there was no really clear mandate for altering the time of meetings substantially, the Council felt that a slightly earlier start would help many members to travel home more conveniently. Meetings would therefore be held in future at 6.30 p.m. instead of 7.30 p.m. An opportunity would present at the Annual General Meeting in May to discuss the matter further if it proved unpopular.

Mr. E. S. Broadway suggested that this fact should be prominently displayed on notices for the next few meetings, and the President thanked him for his suggestion.

Mr. F. Allen stated that this was the only country in the world with two orthodontic societies. He complained that the Society's Council did not contain sufficient representation of orthodontists practising in the General Dental Service, and that of the twenty-five papers presented to the Society in 1964, none was by such a practitioner.

The PRESIDENT pointed out that not only were all members of the Society eligible to nominate candidates for election to the Council, but they had been specifically invited to do so on the Agenda for the October meeting, and at the meeting itself.

Mr. Allen felt that certain vacancies on the Council should be reserved for dentists practising in the General Dental Service, and the President said that Mr. Allen's suggestion had already been considered by the Council, who felt that membership of the Council should be representative of the Society as a whole.

In the ensuing discussion, Mr. J. S. Beresford, Professor W. J. Tulley, and Dr. J. R. E. Mills took part.

The PRESIDENT invited Mr. Allen to make a formal proposition, but Mr. Allen declined.

Mr. G. C. Dickson enquired whether the Council had given their views to the General Dental Council on the subject of professional titles.

The SECRETARY agreed that they had. In this they followed a precedent set in 1957. Their views remained the same; that the time was not ripe for the introduction of specialist titles. They had, however, recommended that if such titles were introduced, orthodontics should be one of them.

There being no further business, the President declared the Annual General Meeting closed.

ORDINARY MEETING, 13 December

AN ORDINARY MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1., on Monday, 13 December, 1965, with the President, Mr. A. J. Walpole Day, in the Chair.

The PRESIDENT said that those present at the Annual General Meeting would have heard the Secretary refer to the death of Mr. Harold Watkin who was an Honorary Member of the Society from 1921 and President in 1933. Mr. Watkin had been a very frequent attender at meetings and was present at the October meeting.

Members stood in tribute.

Minutes

The Minutes of the meeting held on 8 November, 1965 were read by the Secretary, confirmed, and signed by the President.

Election of Honorary Member

The PRESIDENT said that it was proposed by the Council that Dr. L. M. Clinch of 3, Fitzwilliam Place, Dublin, Eire, be elected an Honorary Member of the Society. Those present knew well that Dr. Clinch had been a President of the Society and had contributed on many occasions in the past to the Society's meetings.

He put the proposal to the Meeting and it was carried unanimously.

The PRESIDENT said that it was also proposed by the Council that the following members of the Society should be elected Life Members:—

Miss J. A. Bradley, 25, Elm Way, Worcester Park, Surrey.

Miss R. Caseley, 2, Hillside, Whitchurch, Nr. Pangbourne, Berks.

Mr. G. H. Leatherman, 35, Devonshire Place, London, W.1.

These names were approved, and the President declared these Life Members duly elected.

The PRESIDENT welcomed any visitors who might be present at the meeting and invited them to take part in the discussion if they wished.

He then introduced Mr. J. P. Moss who read a paper by himself and Mr. B. E. Greenfield entitled, '*An Electromyographic Investigation and Survey of Class III Cases*'.

Mr. J. W. Softley proposed a vote of thanks to the retiring President.

President's Valedictory Address

The retiring PRESIDENT thanked Mr. Softley for his remarks. He was afraid for the moment that Mr. Softley was going to refer to the bricks he had dropped; but Mr. Softley very kindly refrained from doing this. He was not different from anyone else in this respect, that when he dropped a brick, it seemed a very much bigger brick to him than it did to the people who observed it. He could remember one or two occasions when he could have wished to have done things a little differently. He thanks Mr. Softley for not mentioning them.

At this stage in the proceedings, there came what was often called a valedictory address, but it was the custom of the Society to keep this as short as possible because of the lateness of the hour and the fact that there had been both the Annual General Meeting and an Ordinary Meeting, one after the other. Some members had been present since four o'clock—first the Editorial Committee, then the Council meeting, and then the General Meeting and the Ordinary Meeting. He was fortunate in having been able to grab four little sandwiches, the only sustenance he had had since 12 o'clock, but some of his colleagues were not even as fortunate as this so they must not be kept waiting too long.

He wished, however, to say, to all members how very grateful he was for the opportunity of being President for 1965. If at times, he had not appeared to be enjoying himself, this was not true. It had been a very enjoyable experience. When he appeared to take things seriously, this was something they expected of their President. This had been an experience which he would not have missed for the world.

He wished to thank on behalf of members, and particularly on his own behalf, the officers of the Society for all their help, kindness, and every kind of assistance possible which they had rendered to him personally, and for all the time and work they had put in on behalf of members to make the Society run smoothly. One must, of course, particularly mention the Secretary, who did a great amount of work in order to make everything run so smoothly; to the Treasurer—the over-expenditure this year was not his fault—he thanked him for the excellent shape of the funds; also the Editor whose work received least attention and yet he probably had one of the most difficult jobs. He gave personal thanks to Dr. Mills for continuing in this office while he had been President and he hoped it would be possible for him to continue for some time, because this was an extremely difficult and painstaking job.

He thanked all the other officers, whom he had not mentioned by name, for their help and their attendance at Council meetings.

It was his pleasant duty next to ask Mr. Rix to come forward and invite him to be President for the next term.

The retiring PRESIDENT *invested Mr. Rix with the jewel of office.*

Mr. Rix had been President of the Society once before, in 1946. On that occasion, the first year of peace, it was said that the war had left very few middle-aged and knowledgeable orthodontists and the Society was very fortunate to have Mr. Rix with his deep knowledge and the fact that he had a lot to contribute to orthodontics for many years to come. Now, 20 years later almost to the day, members knew how very true this was. At the end of his term of office, it was said that Mr. Rix exercised a firm discipline over the unruly children of the Council without affronting their personal pride. He therefore warned members of the Council that they had in Mr. Rix a man of firm purpose and great stature.

Mr. RIX thanked the retiring President for his kind words and members of the Society for electing him President for the second time. He was most grateful for the honour. He would try to hide those qualities inherent in age which would not be in keeping with a progressive society such as theirs. Anyway, he would occupy the Chair only until May on account of the rephasing of the Society's activities.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and Income and Expenditure Sheet

FOR THE YEAR ENDING SEPTEMBER 30, 1965

COLE, DICKIN & HILLS,
CHARTERED ACCOUNTANTS, AUDITORS
18, Essex Street, Strand, London, W.C.2

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1965

1964 £	£		£ s. d.	£ s. d.
11		To *Museum Rent*		10 10 0
		„ *Meeting Expenses:—*		
	47	Hire of Hall	46 13 0	
	74	Refreshments	98 3 4	
	157	Reporting	107 10 3	
	8	Laterns and Films	10 0 0	
	133	Country Meeting (net)	90 1 7	
	52	Northcroft Memorial Lecture	52 10 0	
471				404 18 2
26		„ *Chapman Prize* (1964)		26 5 0
		„ *Printing:—*		
	827	Publications	1200 0 11	
	187	General Printing and Stationery	304 11 8	
1014				1504 12 7
3		„ *Library and Journals*		16 18 6
62		„ *Postage*		75 1 2
156		„ *Secretarial Assistance*		200 0 0
16		„ *Honoraria*		14 14 0
37		„ *Accountancy*		36 15 0
4		„ *Insurance*		4 15 9
7		„ *Sundry Expenses*		12 15 1
22		„ *Depreciation of Furniture and Equipment*		35 3 3
—		„ *Repairs*		2 16 10
353		„ *Excess of Income over Expenditure for the year*		— — —
£2182				£2345 5 4

1964 £	£		£ s. d.	£ s. d.
		By *Members' Subscriptions:—*		
	1635	Subscriptions	1659 9 4	
	18	Areas Collected	67 19 4	
1653				1727 8 8
207		„ *Sale of Transactions*		209 19 2
		„ *Interest Received and Accrued:—*		
	50	Savings Certificates	60 0 0	
	19	5¼% Hertfordshire County Council Stock (net)	18 18 1	
	16	5¼% Corporation of London Stock (net)	15 15 1	
	22	3% Funding Stock (net)	21 4 10	
	50	5% Defence Bonds	50 0 0	
	1	P.O.S.B.	2 0	
	15	Bank Deposit Interest	47 16 7	
	17	J. & P. Coats, Patons and Baldwins Ltd. (net)	18 10 3	
	11	City of London Real Property Co. Ltd. (net)	10 19 8	
	17	British Insulated Callenders Cables Ltd. (net)	20 16 4	
	10	Royal Insurance Co. Ltd. (net)	10 9 5	
228				274 12 3
94		„ *Income Tax Recoverable*		66 6 3
—		„ *Excess of Expenditure over Income for the year*		66 19 0
£2182				£2345 5 4

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

BALANCE SHEET as at 30th September, 1965

1964 £	£		£ s. d.	£ s. d.
		Accumulated Fund:—		
	5261	Balance as at 1st October, 1964 ..	5616 3 1	
		Add: Sale of fractions:—British Insulated Callenders Cables Ltd.	1 9 2	
	2	City of London Real Property Co. Ltd. Capital Distribution ..	—	
	5263		5617 12 3	
	353	*Less:* Deficiency (Excess) of income for year	66 19 0	
5616				5550 13 3
		Creditors and Reserves:—		
	1810	Publications printing reserves (estimated by Hon. Treasurer)	2020 0 0	
	53	Northcroft Memorial Lecture ..	52 10 0	
	13	Hire of Hall	13 10 0	
	11	Museum Rent	10 10 0	
	42	Subscription in Advance ..	59 18 6	
	7	Petty Cash Accounts	24 6 11	
	37	Accountancy	36 15 0	
	66	Secretarial Services	66 0 0	
	26	Chapman Prize (1964)	26 5 0	
2065				2309 15 5
£7681				£7860 8 8

1964 £	£		£ s. d.	£ s. d.
		Fixed Assets:—		
	90	Furniture and Equipment, Balance at 1st October, 1964	68 0 0	
	—	*Add:* Additions during the year ..	77 3 3	
	90		145 3 3	
	22	*Less:* Depreciation	35 3 3	
68				110 0 0
		Investments at Cost:—		
	1083	1200 National Savings Certificates plus accrued interest	1143 6 8	
	1000	£1180 3% Funding Stock 1959/69	1000 5 0	
	1000	£1000 Defence Bonds	1000 0 0	
	597	£600 5¼% Hertfordshire County Council, redeemable stock 1965	597 9 6	
	509	£500 5¼% Corporation of London 1976/1979	508 10 9	
	502	230 J. & P. Coats, Patons and Baldwins Ltd. £1 Ordinary Shares	502 3 6	
	479	£115 City of London Real Property Co. Ltd. Ordinary Stock ..	478 17 9	
	455	£218 British Insulated Callenders Cables Ltd. Ordinary Stock ..	455 2 5	
	479	£50 Royal Insurance Co. Ltd. Stock	478 10 0	
	—	£150 British Insulated Callenders Cables Ltd. 7% Debenture Stock 1985/90 (Amount paid on application)	37 10 0	
6104				6201 15 7
		(Approximate Market Value at 30.9.65 £5954)		
94		*Income Tax Recoverable*		101 8 6
		Cash at Bank:—		
	396	Westminster Bank Ltd.	425 13 5	
	17	P.O.S.B.	17 8 11	
	1000	Deposit Account	1000 0 0	
1413				1443 2 4
2		*Cash in Hand*		4 2 3
£7681				£7860 8 8

P. BURKE
J. F. PILBEAM } *Hon Auditors*

J. S. ROSE *Hon. Treasurer*

We have prepared the above Balance Sheet and Accounts from the books, records and information given to us and we certify them to be in accordance therewith. We have verified the investments and cash at Bank.

COLE, DICKIN & HILLS,
Chartered Accountants, Auditors,
18, Essex Street, Strand, London, W.C.2.

28*th October*, 1965.

SUBJECT INDEX

AUTHOR INDEX